SMITHSONIAN INSTITUTION LIBRARIES

SMITHSONIAN INSTITUTION LIBRARIES

9

975
Cm
1

THE

PRACTICAL MECHANIC'S JOURNAL.

VOLUME I.

APRIL, 1848—MARCH, 1849.

"If my judgment be of any weight, the use of History Mechanical is, of all others, the most radical and fundamental towards Natural Philosophy: such natural philosophy as shall not vanish in the fume of subtle, sublime, or delectable speculation, but such as shall be operative to the endowment and benefit of man's life; for it will not only minister and suggest for the present, many ingenious practices in all trades, by a connection and transferring of the observations of one art to the use of another, when the experiences of several mysteries shall fall under the consideration of one man's mind; but, farther, it will give a more true and real illumination concerning causes and axioms than is hitherto attained."—LORD BACON.

"By viewing Nature, Nature's handmaid, Art,
Makes mighty things from small beginnings grow."—DRYDEN.

GLASGOW:
PRACTICAL MECHANIC'S JOURNAL AND PATENT OFFICE, 33 BUCHANAN STREET.
LONDON: G. HEBERT, 88 CHEAPSIDE.
MANCHESTER: F. WISE, MACHINE DESIGNING OFFICE, 3 COOPER STREET.

T
1
1797

THE

Patent Office, and Registry of Designs,

FOR THE SALE OF INVENTIONS, GRANTING LICENSES FOR PATENTS, AND

REPOSITORY FOR MODELS AND DRAWINGS OF NEW INVENTIONS,

33 BUCHANAN STREET, GLASGOW.

INVENTORS and PROPRIETORS of INVENTIONS are informed, that the whole of the business relating to the obtainment of PATENTS for the Three Kingdoms, the Colonies, and ALL FOREIGN COUNTRIES, or the REGISTRATION of DESIGNS, may be transacted at this Office; a single personal application, or instruction by letter, only being required.

Caveats entered; Searches made for Patents, and Copies or Abstracts supplied; Specifications drawn or Revised, Advice submitted, and the Novelty of proposed Improvements ascertained.

FOREIGN PATENTS.

AGENCIES, in connection with this Office, are established in all civilized countries, enabling Inventors to extend their Patents abroad at a slight expense, particulars of which may be had from Mr. JOHNSON, at the Office, 33 Buchanan Street.

REGISTRATION OF DESIGNS.

ARTICLES OF UTILITY.

Under this Act, Designs for the Shape or Configuration of any article of Manufacture, having reference to some purpose of Utility, may be protected for Three years.

ORNAMENTAL DESIGNS.

Ornamental Designs may also be protected for terms varying from Three Years to Nine Months; the particulars of the proceedings under these Acts may also be obtained at this Office.

MECHANICAL AND ENGINEERING DRAWINGS.

Inventors and others requiring Mechanical, Architectural, or Engineering Drawings, may have the same finished in the first style for exhibition, or to accompany Specifications, either from working Machinery or Sketches—Copies, Tracings, and Reduced Drawings; Engravings on Wood, Copper, or Steel, Lithographs and Zincographs; and Drawings on the Wood for the Engraver.

Just Published,

HINTS TO INVENTORS

INTENDING TO OBTAIN LETTERS PATENT FOR THEIR INVENTIONS, OR TO PROTECT THEIR DESIGNS BY REGISTRATION.

BY WILLIAM JOHNSON,

Consulting Engineer and Patent Agent, and Editor of "The Practical Mechanic's Journal."

To be had *gratis* on application at the Office, 33 Buchanan Street, or free by Post for *two stamps*.

PRINTED BY WILLIAM MACKENZIE, 48 LONDON STREET, GLASGOW.

PREFACE.

TWELVE Numbers of the PRACTICAL MECHANIC'S JOURNAL having been now placed before the public, and a Volume being complete, the Conductors gladly seize an opportunity of returning thanks for the patronage it has received during the first year of its existence.

Like all youthful publications, it has had difficulties to struggle with at the outset of its career; but they are happy to say that those difficulties have not been insurmountable, and they hope to go on with renewed vigour, and a circulation increasing through the next twelvemonth as rapidly as it has done through that which has just terminated. For an explanation of the views with which this periodical was undertaken, they refer to the Address at the commencement of the first number, and they venture to express a hope that the attempt to realize those views has not proved an entire failure; confidently believing, that a comparison between this and other periodicals of the same class will not tend to the disrepute of the PRACTICAL MECHANIC'S JOURNAL.

It only remains for the Conductors to say, that they will continue to use their utmost exertions to make this Journal worthy of the attention of the Engineers and Mechanics of the three kingdoms.

PATENT OFFICE,
GLASGOW, FEBRUARY 24, 1849.

39794

LIST OF PLATES,

AND BINDER'S DIRECTIONS.

Plate		To face Page
I.	Joyce's Double-Cylinder Pendulous Condensing Engines,	9
II.	" " " " ,	*ib.*
III.	" " and Gearing, at Lawes' Bone-Mill, Deptford,	33
IV.	Joyce's Mill-Stones and Gearing,	*ib.*
V.	Robertson's Wheel-Tyre Bending Machine,	58
VI.	Oscillating Marine-Engines with Link-Valve Motion,	*ib.*
VII.	Shanks' Slotting and Shaping Machine,	73
VIII.	Oscillating Marine-Engines with Link-Valve Motion,	80
IX.	Simpson's Duplex Straight-Edge Protractor—Robertson's Equilibrium Lamp,	85
X.	Gorbals Gravitation Water-Works,	97
XI.	Crank-Cutting Machine,	*ib.*
XII.	Gorbals Gravitation Water-Works, Self-Regulating Valve and Sluice Houses,	121
XIII.	Gorbals Gravitation Water-Works, Details of Filters,	*ib.*
XIV.	M'Naught's Patent Double-Cylinder Marine-Engine, Elevation,	145
XV.	Market-House at Blackburn,	*ib.*
XVI.	" Plan and Details of Roof,	*ib.*
XVII.	Steam-Saw for Cutting Rails,	169
XVIII.	High-Pressure Steam Boiler,	*ib.*
XIX.	Nasmyth's Steam-Saw—M'Naught's High-Pressure Boiler—Scott's Hydrant—Walmsley's Safety-Valve,	*ib.*
XX.	Adams' Locomotive Carriage for Branch Traffic,	193
XXI.	Iron Market-House at San Fernando, Trinidad, Longitudinal Elevation,	217
XXII.	" Transverse Section and Details,	*ib.*
XXIII.	Locomotive Passenger Engine "Jenny Lind," Longitudinal Section,	241
XXIV.	" Elevation,	265
XXV.	" Transverse Section through Fire-Box and Boiler,	*ib.*
XXVI.	" " through Boiler and Dome,	*ib.*

THE

PRACTICAL MECHANIC'S JOURNAL.

EDITED BY WILLIAM JOHNSON.

THE CONDUCTORS' ADDRESS.

In placing before the Public the first number of the Practical Mechanic's Journal, it will be expected that we should say a few words by way of introduction.—

We were once sarcastically styled by a foreigner, a nation of *shopkeepers*. If the saying had to be said over again, it would be a politer phrase, and one nearer the truth, to call us a nation of *manufacturers*. The number, variety, and magnitude of our manufacturing establishments; the quantity, complication, and nicety of our machinery; the extent of our shipping and inland steam locomotion; all these declare a people who are determined to be at the head of producers and sellers, so long as consumers and purchasers can be found. In what corner of the globe are we not seen buying or selling? Where is it that we are not found collecting luxuries for home consumption, and tendering the products of our own industry in exchange? There is no such spot, for we export and import to and from every quarter. Now it is quite clear that, unless we have the power of creating gold, and coining it at our own will, we must *sell to buy*, and *buy to sell*. We cannot go empty-handed to foreign countries: we must either offer money or money's-worth for their cotton—their sugars—their timbers—and their wines—or we do not get them at all. Precisely, then, in proportion to the extent of our commerce, must be the extent of our manufactures. Both are so completely dependent on each other, that whatever affects the one acts on the other. The larger and closer is the net-work of commerce, the greater is the activity infused into manufactures; and, as demand governs supply, there is a blight upon home industry the moment anything goes wrong abroad.

Now, the right arm of manufactures is machinery; for without the aid of machinery, not even what we require in our own country could be supplied, and many articles now considered necessaries of existence would never have had being, or would be confined entirely to the wealthy classes. But by machinery we abridge labour, and thus produce in larger quantities, and at less cost. With this help, we can manufacture at a rate adequate to any amount of demand, and with an immense saving of expense; and thus we are able to sell goods at a much cheaper rate than we could otherwise possibly do. By manufacturing on a large scale, and selling cheap, the British producer gains two ends: he keeps possession of the foreign market against foreign rivals, and he extends his home market. The Public is ever ready to adopt conveniences, and indulge in luxuries; so that, when the bar of expense is removed, a demand instantly arises, and that demand increases as the price is lowered. Thus it is the policy of the producer to sell cheap, in order that he may sell much. But there is another reason why the manufacturer lowers prices, and that is—competition. There are rivals in the market, and abroad a very formidable one—the local producer. It is the inevitable tendency of all successful enterprise to engender rivalry, and then there is a keen struggle to *make* cheaper, with a view to *sell* cheaper. The engineer and mechanist are again called into counsel, and their powers of invention are taxed for new means of further abridging labour. Thus the natural desire of improving is stimulated into livelier activity, both by the expectation of an extended market and by competition, and thus all existing combinations are perpetually undergoing review; new contrivances and applications are sought out, old forms and elements are re-arranged, and the whole domain of mechanical science is receiving diligent scrutiny and culture with a view to improve and perfect.

These observations may seem more suited for a discourse on Political Economy, than for the first page of our Journal; but we beg leave to intimate, that they are essential to the support of that part of the argument which we hope our readers will at once see the force of—namely, the utility of publications like the present. If mechanism is necessary, then of course are mechanists; and they must possess not only an inventive genius, but a mechanical education. Such an education cannot be altogether communicated by practical experience; but recourse must be had to books, with a view to extend and perfect what is learned by personal experiment. Besides, before the inventor can satisfactorily go to work, he ought to know what already exists; for how often does a process in one department afford valuable hints for improvements in another? The utility, then, of a Journal which records the progress and development of the mechanical arts and sciences; registers deserving inventions and improvements in machinery and engineering; and chronicles facts connected with these important branches of human industry, must, we think, be admitted by all. If properly conducted, such a publication ought to be of advantage to the manufacturer and workman, the inventor and the student.

To the Manufacturer it will give information as to the improvements which are continually being introduced into the arts and manufactures at home and abroad; a knowledge of which is absolutely necessary, in order to keep pace with the requirements of the times, and to compete successfully with rival producers.

It will assist the Workman and Student with explanations on questions of principle and detail; it will yield parallel applications of the one, and new illustrations of the other, and will put all readers on a level with the discoveries of the age.

The Inventor will have the means of making the fruits of his labour known to the Public, and thus of reaping a reward proportionate to the merit of his invention; whilst the Public will be benefited by the diffusion of valuable discoveries.

With the view of opening a communication between the class of inventors and the body of manufacturers, and of assisting the education of the student, the PRACTICAL MECHANIC'S JOURNAL has been set on foot; and, if we fail to make it as acceptable to our readers as they would desire, it will not, we assure them, be occasioned by a want of exertion on the part of the Conductors. We shall exert our best endeavours to bring before them the most useful discoveries in Mechanics, Engineering, and the Practical Sciences, which shall from time to time be made, and shall illustrate the details by explanatory Drawings. A series of Practical Papers will explain, in an intelligible manner, the minutiæ of various arts. Articles embodying general views and outlines of the different branches of scientific knowledge, will be perspicuous expositions of their respective subjects. In fact, without promising to furnish our readers with a complete Encyclopædia, we may yet say, that everything connected with Natural Science, directly or remotely bearing upon mechanical labours, will, in its turn, receive attention. Thus the leading facts of Science will be communicated in the way of compendious abridgment, for the benefit of the younger members of the community, or of those who wish to acquaint themselves with principles freed from technicalities.

The Engravings, Lithographs, and Woodcuts, with which we shall illustrate the text, will be numerous and accurately drawn, so that the reader will have no difficulty in comprehending the subject under notice.

It will be part of our plan to watch the proceedings of Engineers and Mechanics in foreign countries, to report the transactions of Scientific Societies, and to examine all Literary Works and Patented Inventions, brought under our notice, with strict impartiality, and with reference to their real merits.

If we succeed in carrying these intentions into performances, we venture to think that our Journal will be found of considerable service, and we shall hope to receive from the Public that support which it may deserve. Again we repeat, that no exertions shall be wanting on our part to furnish our readers monthly with a really useful assistant and adviser.

INVENTORS AND INVENTING.

To buy in the cheapest and sell in the dearest market, is the essential spirit of commercial enterprise; hence, the trader's chief endeavour is to sunder these extremes as far as possible, by the elevation of the one and the depression of the other. The spread of knowledge—general and technical—continually affects these positions, and he who is best informed gains the advantage. The manufacturer, who, in himself, or through the workmen he employs, possesses the best information as to the operations to which he devotes himself, is the proprietor also of the greatest number of ideas; and these ideas, in turn, direct him to those expedients best suited to his purpose, which we term inventions. Thus he accomplishes feats, which, to his less gifted contemporaries, are practically unattainable; and while he offers a boon to the world, he is himself enriched. The genuine inventor then stands at the head of cheap producers, and ranks the highest as an effectual improver of nature's raw materials. Herein lies the difference between the inventor and the non-inventive capitalist: capital is simply another term for power; and power, to be available, requires direction, and this condition involves the application of inventive ideas. We are told of an old lady, who, running over a long list of complicated details, each of which if performed would have required not one but many strokes of genius for its accomplishment, directed her factotum that they were all to be done "somehow by means of a screw." The question was—how to apply the screw. The story exemplifies the failings of the ingenious schemer; he has an idea of revolutionizing some branch of manufacture, but does not fall upon the proper system for realizing his theory.

Every healthy branch of invention—every tendril of improvement, is a gem sifted from a vast heap of refuse; for one successful venture, how many argosies are wrecked! The dreaming perpetual-motion seeker has, inadvertently enough, rendered good service to the more commonplace mechanician, whose sober ideas have taught him to select ingenious contrivances for application to simpler purposes. The wheels, levers, and magnetic powers pressed into service for the pursuit of this *ignis fatuus*, have reappeared in later years as contributors towards the efficacy of loftier ends. From being intrinsically wonderful, they have been as it were intellectualized, readapted, and elevated to that highest post of honour—usefulness. The flute-player of Vaucanson; the automatic duck by the same hand; the chess-player of M. Kempelen; and, in later years, the speaking automaton of M. Faber—all these have had, or will have, their share in the improvements of the present and future years.

In whatever manner the results of genius appear to be thrown away or misapplied, we have the consolation that whatever is good is not entirely lost; though it may be hidden, it may be desecrated, but it is not extinguished. A course of inventive reasoning only, founded upon man's daily experience of actual results, could have produced the alchemical transmutation of a block of ironstone into a modern steam-engine. Place the two side by side; compare the crude simplicity of the one, with the systematized complexity of detail of the piston, the valves, and the boiler of the other: divide the sum of a finished railway, by the first stroke of the pickaxe; or examine the silkworm, and then contemplate the intricacies of the brocade. This done, we shall be in a condition for understanding in some degree the gradual development of improvement. We may then possibly comprehend how it is, that trifling modifications of existing machines or processes, steadily and progressively applied, always succeed, while grand subversions of our preconceived notions always fail.

The rotatory engine offers a case in point. No one can possibly doubt for a moment that the rotatory engine possesses theoretical advantages far outweighing the best qualifications of the reciprocating engine, as regards weight, space, direct application of power, and, under certain conditions, first cost. With all this in its favour, the rotatory engine is still in the background; for, out of the thousand and one schemes of the kind, we cannot select one which comes up to its credentials. The advocates of this class of engine have all along aimed at too much; they have attempted to utterly overturn the well-arranged and well-understood system of the day; and the result is, that they have not even shaken it.

Inventions, to be soundly judged, must be valued commercially. The question is not, what can the machine do? but, at what cost does it perform it? The scientific records of the times furnish us with daily illustrations of our meaning. In them we find inventors building up masses of mechanical and chemical expedients, without entering into calculations as to the expense of their style of architecture, or the cost of maintenance of the edifice. Wheel is added to wheel, and lever to lever, until the enthusiastic dreamer arrives at the perfection for which he has struggled. His machine doubtless is ingenious, nay wonderful: perhaps it embodies the production of distinct fabrics, which before required the conjoint operations of two or several machines; or perhaps it both spins and weaves, while others only spin or weave. It may indeed accomplish unheard-of ends; but—and here is the rub—perhaps it does not prove itself a cheaper agent than its simpler predecessors. As the world waxes older, sweeping assertions demand a more careful analysis, and the word *impossible* is no longer fitted for its original applications. Impossibilities yearly become scarcer, for there are few ideas which may not now be consummated, and wrought out to perform their part; but, of these, how small a portion actually improves the condition of man!

The practician of the present day is too prone to rail at science and inductive theories, and shows us how many eminent discoveries have been either the result of accident, or the offspring of illiterate and unscientific men. It is true, that to accident as a *means* we are indebted for invaluable improvements in all branches of science; but it is no less true that such casualties, unseized by a vigorous intellect, could never have resulted in permanent improvements. Myriads of apples might have fallen, and hosts of spinning-wheels have been overturned to no end, had not Newton or Crompton been the observers. We never read of the successful discoveries of unlearned men, without fancying how vast an amount of *intellectual force* would have been saved to them, had they been supplied with a firm substratum of rudimental knowledge.

It is, however, a pleasing feature of the present day, that inventions are becoming rather the means whereby our direct and absolute wants are supplied, than the chimerical idealities which too often flitted before the imaginations of our ancestors, without a definite reason in view. Each improver adds somewhat to the common stock of information, as he labours to discharge his own particular duties in the manner most accommodating to his pursuits. We live in the age of *application;* materials and immaterialities are constantly being adapted to the strangest positions. We paint by light—we engrave by electricity—and the same agent faithfully transmits for us the most complex messages. The thin curling vapour of water finds an application as an ever-contracting bond of connection between the city and the hamlet—the island and the continent.

It is a clothmaker, an ironfounder, and a printer, and lately we observe it has commenced business as a confectioner. Of iron we construct far-off sea-going ships: and even copper is shaped into boats; the dominion of leather is usurped by gutta percha; an old rope supplies the material whereon we write: this again is reapplied, and paper-maché ornaments our drawing-rooms. The Jacquard machine, in addition to its legitimate office as a weaver of ornament, now prints yarns and cloth, weaves music, and lends its aid to the iron-punching apparatus. Water is an illuminator; and ether and chloroform soften our physical pains. Cotton is now a rival of gunpowder; and, in the atmospheric railway, the air we breathe is compelled to toil and sweat for the benefit of man. The Positive is triumphant, and Romance is obsolete. Such are the results of scientific applications of experienced effects, and in the same train must all future inventions follow.

THE POWER OF A BLOW.

"Now, what do you call the power of that blow?" is the question of every tyro who beholds the giant feats of Nasmyth's steam-hammer or pile-driver; and strange enough, the query often poses far older heads. Of all the numerous and intricate branches of dynamics, the subject of momentum is perhaps treated in the most mysterious manner; and the glimmer of knowledge of the majority of mechanics, on this head, serves a purpose little better than that of rendering their mental "darkness visible." Apart from the interest of the subject, as a matter for general inquiry, the consideration of momentum deserves a front rank in the discussions of the practical mechanic, from its direct bearing upon the intimate concerns of his avocations. Take for example the fly-wheel, as a case in point. How few can arrive, in a business-like manner, at the actual labouring force stored up in a fly-wheel of known weight and velocity! What we are about to urge in the present remarks, may perhaps direct the student to *think* for himself.

In considering the force of a blow, we may imagine the hammer, or falling body, to act the part of an accurate self-adjusting machine, for condensing or expanding the labour exerted in producing the motion. Thus we may suppose the labour to be exerted at one end of the lever, *a*, *b*, *c*, fig. 1, say from *a* to *a*, and the blow to be given at *c*, say from *c* to *c*. then the hammer will be represented by a self-adjusting apparatus, whereby the fulcrum *b* is moved to and fro, accordingly as the substance struck is hard or soft. We will suppose some soft substance to be struck, as lead or wax; therefore, the impression of the hammer, or the extent of the blow (from *c* to *c*), bears a large proportion to the extent of the labour (from *a* to *a*); in other words, the labour is only slightly condensed. In fig. 2, the accommodating hammer-fulcrum has increased the power of the lever, for a hard substance as iron; the labour from *a* to *a* remains the same, but the blow from *c* to *c* being of small extent compared with the labour, contains the latter very much condensed. The same blow of course produces an effect upon a hard substance as well as upon a soft one, but the labour is more concentrated or condensed in one case than in the other. We may also imagine the fulcrum to shift during the blow; for when the hammer first falls, the body struck generally presents less resistance than after it is compressed by the blow. The motion of the fulcrum during the blow will, therefore, generally be towards *c*, the rate and extent of its motion varying exactly with the resistance met with and the power applied. This nicety of consideration, for practical purposes, may be disregarded, since it is still the *same* force condensed or expanded by a mechanical expedient.

Fig. 1.

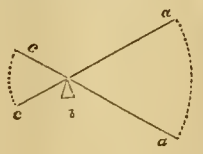
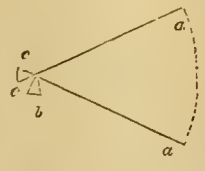


Fig. 2.



The following exposition is based upon an axiom in mechanics, which may be expressed as follows:—The whole effect produced by mechanical expedients is always equal to the whole cause or labour exerted; in other words, mechanical expedients merely condense or expand labour. For example, a power exerted over six feet, and producing a result in one foot, is condensed into one-sixth, and in that space the result is six times as great as the labour exerted in the same distance; conversely if the power move one foot, and the result is obtained in six feet, the power is expanded six times, and in equal distances the power is six times the result; but the total result is in each case equal to the total labour employed. Thus 100 lbs. *raised* six feet are equal to 600 lbs. *raised* one foot; and, conversely, 600 lbs. *raised* one foot comes to the same thing as 100 lbs. *raised* six feet.

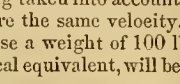
The subject then divides itself into two branches:

First, The momentum, mechanical equivalent, motive power, or labour stored up in the hammer in motion, ready to be exerted in a blow; and,

Secondly, The power of the blow.

By momentum, mechanical equivalent, motive power or labour stored up in a moving body—terms which may be considered as synonymous, and which are used indifferently for each other—is meant the number of lbs. raised one foot that are necessary to raise the body by mechanical expedients (the time occupied in lifting not being taken into account), so that falling by unassisted gravity, it may acquire the same velocity.

To illustrate this by an example: Suppose a weight of 100 lbs. to fall through 16 feet. Its momentum, or mechanical equivalent, will be 1600 lbs. raised one foot; because a lever, *a*, *b*, *c*, having a weight of 1600 lbs. at *c*—*a*, *b*, being sixteen times the length of *b*, *c*, then 100 lbs. at *a* would be raised sixteen feet, while the 1600 lbs. at *c* descended one foot; and by the axiom already given, that cause and effect are equal—the effect of the falling body must be equal to the labour of raising it to the height from which it fell.



Momentum could not be manifested in a body having no weight, for the simple reason, that no labour would be required to move an imponderable body, unless some resistance was offered to its passage; and then the effect would be at once produced by overcoming the resistance without being reserved in the body itself as momentum. If pressure be exerted on a falling body, power is expended; mere pressure has no weight, but pressure on a falling body is labour employed on weight, and is therefore stored up as momentum by an increased velocity due to the pressure or force exerted. By the axiom, the momentum of a falling body urged downwards by pressure, must be equal to the weight required to raise the body, against the pressure, to the height from which it fell. Of course the *blows* from two bodies of equal weights and velocities, but one pressed down and the other unassisted, are not equivalents; the difference arising from the continued pressure during the blow; but if the pressure is removed the instant before the blow is struck, it is evident that the blow from, or momentum of, a falling body, having a velocity acquired by pressure, must be equal to the same body having the same velocity acquired by the force of gravity or *any other* source of motion; thus bringing the momentum of *all* moving bodies under the same laws. Then the momentum of 100 lbs. falling through 32 feet, and urged downwards by a pressure of 100 lbs. in addition, would be 100 lbs. raised against a pressure of 100 lbs. for 32 feet, this being mechanically equal to 200 lbs. raised 32 feet, or 6400 lbs. raised one foot.

It may be shown that a falling body, urged by a pressure equal to its weight, for 32 feet will have acquired a velocity equal to 64 feet per second, and if the same body fall by its own gravity for 64 feet, it will acquire the same velocity; therefore, a weight of 100 lbs. falling through 64 feet will acquire the same momentum as if it fell through 32 feet urged by an additional pressure of 100 lbs. Now, the velocity acquired by 100 lbs. falling 16 feet, is 32 feet per second, and its momentum is 1600 lbs. one foot high; 100 lbs. falling 32 feet acquires a velocity of $45\frac{1}{4}$ feet per second, and a momentum of 3200 lbs. one foot high; and 100 lbs. falling 64 feet acquires a velocity of 64 feet per second, and a momentum of 6400 lbs. one foot high; therefore, the momentum of falling bodies of equal weights are as the heights fallen through, or as the *squares* of the velocities. Therefore, the momentum of a body in motion is equivalent to the number of feet it must be raised to acquire the same velocity by falling, multiplied by the weight in lbs. The height may be found by the well-known formula, $(\frac{V}{8})^2 = S$. The rule, therefore, is:—Divide the velocity in feet per second by eight, and multiply the square of the quotient by the weight of the body in lbs. To give a practical example, let it be required to find the momentum, or mechanical equivalent, of a two ton hammer (4480 lbs.), moving with a velocity of 16 feet per second. Then by the rule $(\frac{16}{8})^2 \times 4480 = 17{,}920$ lbs. raised one foot, the momentum required, and a two ton fly-wheel moving at the same velocity would have the same momentum. If the hammer above-mentioned strike 80 blows per minute, $17{,}920 \times 80 = 1{,}433{,}600$ lbs. at one foot per minute, would be the *power* required to raise the hammer; taking 33,000 lbs. raised one foot per minute to be a horse power, it may be expressed as $43\frac{1}{2}$ horse power nearly. This must not, however, be taken as the power of the *blows*, any more than the power applied to the wrench is the power given out by a screw: it is only the power employed in lifting the hammer; if it be condensed or expanded, it is increased or lessened in that particular instance.

By the *power* of a blow, is understood the force or *pressure* of a number of lbs. moving at the rate of one foot per minute, that will produce the same effect in the same time. Referring to the last problem, suppose the blow to occupy one-eighth of a second, then the labour of raising 17,920 lbs. one foot (*i. e.* the momentum of the hammer), would be condensed into one-eighth of a second. Now, 17,920 lbs. raised one foot in one-eighth of a second, is equal to 8,601,600 lbs. ($17{,}920 \times 480$ the 8ths of a second in a minute) raised one foot in a minute; this reduced as before, is $260\frac{1}{2}$ horse power, the power of the blow due to momentum

only. The rule, therefore, is, Divide the momentum by the duration of the blow in minutes. If the hammer is urged down by pressure as well as gravity, and if the pressure continues during the blow, as is the case with hammers when their weights act as pressure, then a separate calculation is required for the increase of the power; in fact, we must take the time and distance the pressure moves during the act of striking. Referring again to the last problem, let us suppose the velocity of the hammer to be acquired by a pressure of 1000 lbs., and the blow to pass through half an inch, all other circumstances remaining the same; then we have 1000 lbs. added to 4,480 lbs. (the weight of the hammer) moved through half an inch in one-eighth of a second, that is, 5,480 lbs. 4 in. per second, or 20 feet per minute, or 109,600 lbs. one foot per minute, or nearly 3½ horse power. The total power of the blow, both from momentum and pressure, would therefore be 264 horse power, the rule for pressure only being,—multiply the pressure by the distance moved in feet, and divide by the time in minutes. It is thus seen that pressure at the *same* velocity adds very little to the power of the blow; but if it increase the velocity of the hammer, it increases its momentum as much as if it fell through a greater space.

For convenience, we have adopted the usual mode of computing horse power, but would not be understood as subscribing to the doctrine that a *weight* of 33,000 lbs. *moving* at the rate of one foot per minute, are equal to 1 lb. *moving* at the rate of 33,000 feet per minute; they are equal only when either the motion is such as to give rise to no momentum, or when they are considered merely as pressure, *i. e.* bodies having no momentum.

If it be borne in mind that, in many cases, the machinery connected with the hammer absorbs much of the power exerted, the only circumstances for consideration are—

1. That hammers of the same velocities and unequal weights produce results in proportion to their weights; and, 2. That all hammers produce results in proportion to their momenta (*i. e.* in proportion to the power exerted in moving them). Therefore, the momentum of a body in motion is as its weight, and (as before shown) the square of its velocity. The alteration of the striking surface may concentrate or disperse the effects of the blow, but the whole of the effect evidently remains the same.*

In the first of these circumstances, we may suppose, for the sake of illustration, one hammer to be a cube of 2 inches on the edge, and the other a bar of 1 inch square and 2 inches long, both to have the same velocity, and the striking face of the cube to be one of its sides, and of the bar one of its ends. Now, the cube is only four such bars ranged side by side; and therefore the blows must be in proportion to their weights, the blow from the cube being four times as energetic as that from the bar. A little reflection will suffice to show that the law is general, that all bodies of the same velocities produce results in proportion to their weights. In the second circumstance, that (irrespective of pressure during the blow) moving bodies produce results in proportion to their momenta, we may take for example a blow from a fly-wheel—this is due to momentum only. If various powers be exerted in turning several wheels of unequal weights, then as, by the axiom, cause and effect are equal, if the whole effect be produced suddenly from all the wheels by their stoppage, that is by a blow, results in proportion to the power used must be manifested, and as momentum is merely the equivalent to the power employed, the result or blow must be in proportion to the momenta of the bodies, those of equal momenta producing equal results.

A blow cannot be compared with anything but *power;* by which we mean, that force applied with rapidity is its only equivalent. A thin cane or wire, employed as a supporting column, bends with a slight *pressure;* yet a tolerably smart *blow* may be applied to it, so as to produce its full effect without bending it. Again, a blow and pressure on dry sand are obviously incomparable; it is therefore evident, that we can find no equivalent to a blow, if *time* be omitted in the calculation.

We will conclude the subject by quoting a rule and problem which are frequently set before practical men for their guidance, and will endeavour to show the absurdity of the very common theory of "mass and velocity."

"Suppose a leaden bullet, which weighs 24 lbs., to be let fall from a height of 404 feet, which corresponds to the height of St. Paul's cathedral, with what velocity will the ball strike the ground, and what will be the momentum or force of impact?"—(*Vide* "A Treatise on the Steam Engine," by the Artizan Club, p. 30.)

The velocity is found to be 161.216 feet per second, which we believe to be correct; but Archimedes defend us! "By the general analogies for constant or uniform forces, the momentum is proportional to the mass multiplied by the velocity; consequently, we have 161.216 × 24 = 3869.184 lbs. for the momentum or force of impact." If we were to take feet per minute instead of seconds, or inches instead of feet—and we do not know why we should not, seeing we should still multiply the mass by the velocity—the momentum, by *rule*, would be most considerably increased. But having got 3869.184 lbs., what are we to do with them? Are they to move an inch or a mile? Are they to move quickly or slowly, or are they to stand still?

No one can deny that 3869.184 lbs., moved a certain distance at a certain velocity, may produce effects equal to the momentum of the ball; but as we are not told if the three thousand and odd lbs. are to be stationary, or are to move with the American rapidity of greased lightning for a twelvemonth, we must object to the notion that that particular weight, without controlling circumstances, is any equivalent to the momentum of the ball.

If the ball fall through 404 feet, as cause and effect are equal, the momentum, or amount of labour stored up, must be equal to the labour of raising 24 lbs., 404 feet; and this reduced, to suit particular purposes or general convenience, is the equivalent to the momentum. D.

* If pressure be continued, or if the weight of the body act during the blow, it is force exerted beyond that causing the motion, and must therefore be taken into the account; but if the pressure cease the instant of striking, it does not interfere with the result.

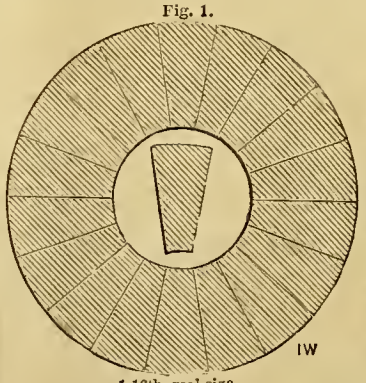
ROUND CHIMNEYS.

In the year 1846, I was led to consider what means ought to be resorted to for the amelioration of the condition of the chimney sweep, whereby this degraded class might be elevated in some degree from the depths of uncivilization into which it has fallen. After duly weighing the matter, I arrived at the conclusion that to strike at the root of the evil, the most practical plan was to construct all chimneys in such a manner, as to be more economically swept by machinery than by the climbing boy. Were no householder to permit a living sweeping machine to ascend his chimney, the evil might certainly be removed; but the impotence of the law in such a point, is exemplified by the fact that in spite of its enactments to the contrary, the system is still adhered to.

There are two forces at work against the climbing boys: one is, that the housekeeper insists upon his chimney being swept clean, and the present state of the flues does not permit of this being done by machinery; the other is, that the master sweep obtains more soot by hand-sweeping. The system of sweeping square chimneys with circular brushes, is unphilosophical, and practically bad. To remove this objection, I propose to improve the brushes for existing chimneys, and to construct all future ones upon a different principle. It is obvious enough that flues of square sections ought to be swept with flat or square brushes. I should say that ordinary flat brushes might be made to answer well, if attached to the flexible rods at present in use. If circular flues were adopted, they might be most effectively swept by the ordinary circular brushes, and to my mind, this form of flue may be rendered more ornamental than any other.

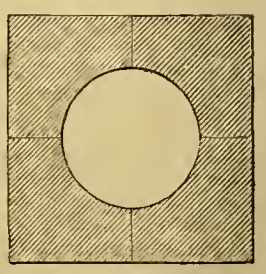
The accompanying drawings will serve to show that three different shapes of bricks will be sufficient to meet the demands of every case.

Fig. 1.



1-16th, real size.

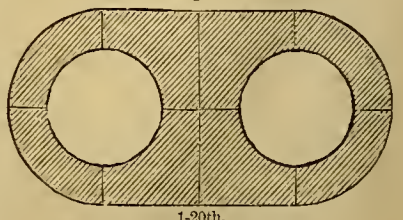
Fig. 2.



1-16th

The single chimney, fig. 1, is suitable for houses built with 9-inch walls, the bricks being 9 inches long, and the internal diameter of the flue 12 inches; this is the size I consider the best. But to build the fire-places, and that portion of the chimney which is within the house, the bricks represented in fig. 2 are best, as they will fit in square with the walls. For the single chimneys of houses with 4½ inch walls, I would recommend the latter shape for the interior work, and the same, rounded *externally* for the upper visible part. All

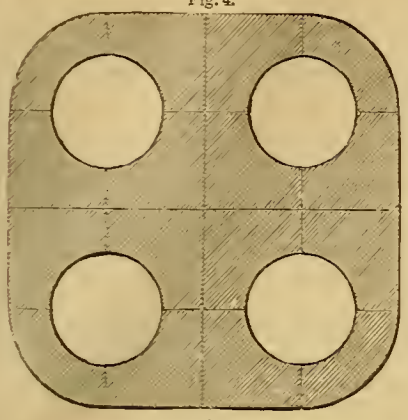
Fig. 3.



1-20th.

single chimneys would look much better, if built round, and they would present less area of surface to the wind; but by the adoption of the combinations of fig. 2, with the same, rounded externally, the present arrangement of chimneys need not be changed. The dimensions of bricks (fig. 1), are—length, 9 inches; thickness, 4 inches; wide end, the arc of a circle, 15 inches radius, subtending a chord 5 inches long; length of chord at narrow end, 2 inches, subtending an arc of a circle 6 inches in radius. Eighteen such bricks will form a "course." In fig. 2, four bricks form a course; they are each 4½ inches wide at the ends, and the interior circle being 12 inches diameter, the square outsides are 10½ inches long.

Fig. 4.

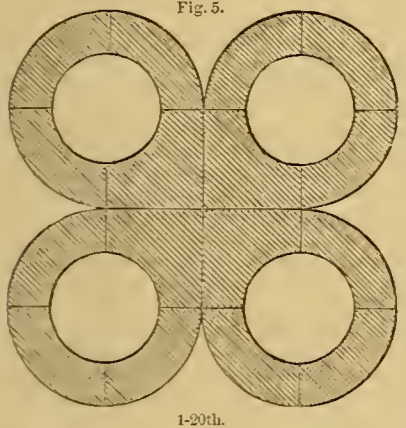


1-20th.

Fig. 3 is a combination of the square and segmental bricks, showing the arrangement of the flues. Figs. 4, 5, 6, and 7, represent various combinations for a series of flues. Some of these forms possess great beauty, but they are only a very few of the plans which may be followed out by the adoption of these bricks. Any of them may be cased with common bricks, so as to make the sides 9 inches thick. As to the external appearance of the chimneys, however, that must be left to the task of the architect, my ideas having reference only to the interior. Much may be done in behalf of the cause I am advocating, if the matter is only considered about, and if I shall have succeeded in promoting the use of the inanimate sweeping machine, in place of the living one, in however small a degree, I shall deem the present attempt not altogether in vain.

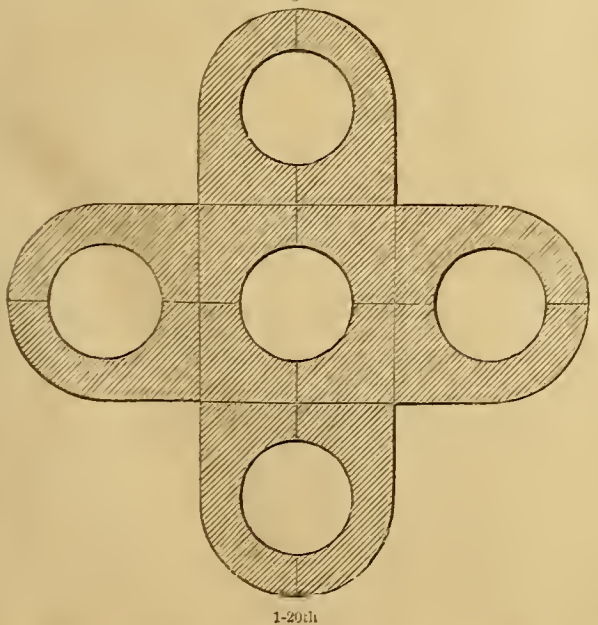
JOHN.

Fig. 5.



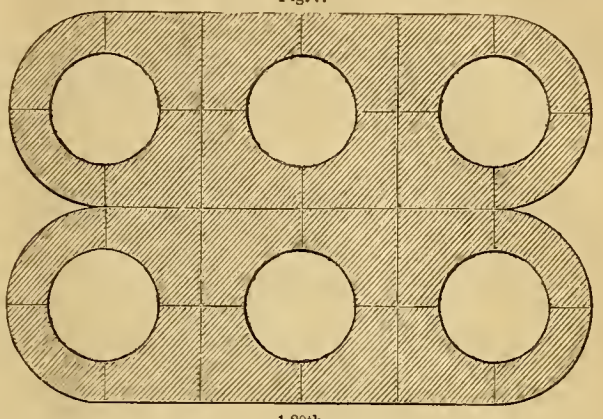
1-20th.

Fig. 6.



1-20th

Fig. 7.



1-20th.

THE FIRST VOYAGE ACROSS THE ATLANTIC.

In the course of the present year, an interval of three centuries and a half will separate us from the day when Columbus set forward into seas which never mariner's keel had ploughed before, to search for another empire to be added to the crown of Spain, and for other nations to swell the population of Christendom. Under the inspiration of a great idea, the difficulties and the space that divided Europe from that undiscovered country in the west dwindled into insignificance, when he found how easily his mental eye penetrated to it, and whilst his visionary imagination crowded it with gorgeous objects that seemed to promise an exceeding great reward to the possessor, even if they did not enhance the grandeur of the project. An ocean which to every one else was full of mystery and peril presented no barrier to him; the possibility of there being land beyond it was to him a certainty, for the curtain of distance which arrested the vision of those around him, his sight pierced through, and rested upon a substantial object invisible to others. The constancy with which he clung to his convictions, when there was so little tangible proof to ground them, and his entire devotion to their realisation, seem rather to belong to the history of a divine revelation and a religious faith, than to the workings of a merely human spirit of enterprise. It is not an easy matter for us of the present generation to conceive the courageous hardihood which braved the dangers of a vast ocean for the first time, with ill-made ships and insufficient tackle. When we see noble vessels leaving our ports every day for the American continent and the islands of the Atlantic, laden with persons who look upon the voyage as a trip of pleasure, and calculate to a day their arrival and return, we are apt to forget the difficulties that beset the first navigators, —barks of a structure unfitted to contend for any length of time with winds and waves—a grievous want of scientific knowledge and practical experience—and, more than all, the chimeras of superstition. All this slips out of our memory, and we are ready to ask if Columbus deserved the reputation he has obtained? He did, and the history of his discovery is so full of the instruction which successful perseverance eminently teaches, that we shall make no apology for once more recounting the principal circumstances by which the "needy son of an Italian woolcomber (to use the words of Lord Bacon on another occasion) was made a person heroical, and his memory cumulate with honours."

Christopher Columbus was born at Genoa about the year 1435, the eldest of a family of three brothers and a sister. Having shown a strong inclination for a seafaring life, and a taste for geographical knowledge, his father, though not wealthy, sent him to the university of Pavia, to pursue his studies in geometry, geography, astronomy, and navigation, but, the boy did not remain long there before he commenced about the age of fourteen, a practical acquaintance with the sea. For some time he was engaged with some of those cruising expeditions and hostile enterprises, which were so common in those days, when nation was armed against nation, and state against state, giving rise to much piracy upon the Mediterranean and the adjacent seas. On one occasion the vessel under his command became inextricably fastened by grappling-irons to a Venetian galley, whilst engaged in a fierce encounter, and the latter taking fire, one blaze enveloped the two ships. To save themselves from a horrible fate, the crews leapt into the water; Columbus, being a

dexterous swimmer, succeeded in reaching the shore, although ten leagues distant. In such a hard school was he reared who was the first governor in a new world, and he needed all his experience in steering his course thither, and in ruling the turbulent spirits under his charge.

It is a singular circumstance, that of the lands discovered, and the colonies founded, by the spirit of enterprise rife in the fourteenth, fifteenth, and sixteenth centuries, how few remain in the hands of the original adventurers. The little nation of Portugal had taken the lead in that career of geographical discovery. The coast of Africa was explored, the islands near the north-east shore visited, and the passage to India round Cape Horn discovered by navigators under the patronage of their princes, and the fame of the Portuguese discoveries attracted a concourse of learned and adventurous persons to Lisbon, to engage in the expeditions so frequently undertaken. Columbus, amongst others, repaired to the Portuguese capital, and after he had fixed his home there, he sailed occasionally to the coast of Guinea. When not otherwise employed, he added to his income by constructing maps and charts for sale. Part of the money raised in this way, he transmitted to his aged father in Italy, to be expended in his support, and in the education of his younger brothers. At Lisbon he married a lady, the daughter of a captain who had acquired celebrity by his maritime exploits, and had been appointed governor of the island of Porto Santo, which he colonized. Through his marriage he obtained possession of the maps and journals of his wife's father, then deceased, and thus acquired a knowledge of the routes and ideas of the Portuguese sailors. With a piercing intellect and an excellent judgment, Columbus united an excitable imagination. The great problem of that period was to seek out a path by water to India, in addition to the route overland, for it was hoped that the solution of that problem would pour immense commerce and endless wealth into the kingdom of Portugal. In prosecuting their attempts to find such a passage, they directed their efforts to the discovery of a termination of the African continent, with a view to doubling it and sailing eastward. But they carefully kept within a moderate distance of the coast, and feared to venture into that unmeasured world of waters that lay to the west. By sedulously studying the geographical treatises of the ancients, and reflecting upon the discoveries of more recent times, Columbus came to the conclusion that the earth was of spherical form, and not a mere uneven plain, varied by land and water. This being assumed, it followed that, by penetrating the great western ocean, the coast of India must sooner or later be reached, the only matter of doubt being the distance which separated that coast from the coasts of the old world. Columbus then entered into calculations, by which he made it appear, that the circumference of the globe was less than it really is; and thus he reduced the interval to a less fearful extent. Hence, it seems that the ultimate aim of every one was nearly identical, since it was no other than to arrive at that part of Asia, termed India, by a maritime passage. No one seems ever to have dreamed that a mighty barrier of *terra firma* lay embedded in a continent of water, to prevent the direct progress of the seaman from whatever point he set sail.

The possibility of safely pushing through the western ocean daily impressed itself deeper upon Columbus. His enthusiasm acted upon the religious tone of his mind, and inspired him with the belief that he had been selected by heaven for the accomplishment of great purposes. He pointed to paragaphs in the sacred scriptures which seemed darkly to hint at the great discovery he contemplated; and he descanted with fervid eloquence on the magnificent idea of bringing the ends of the earth together, and converting countless nations from Paganism to the true faith. He had dreams of the Ophir of King Solomon, of the Aurea Chersonesus of the Greeks, of the territories of the great Khan, whose grandeur and magnificence Marco Polo had described. At length Columbus obtained an audience of the king of Portugal, to whom he expounded his views on the subject of reaching the East by a shorter route than those heretofore known. If the king would place a sufficient number of ships and men under his charge, he offered to open a communication with the most powerful and wealthy of oriental potentates. This proposition was referred to a private junta, and then to the royal council, but in both instances an adverse opinion was expressed. The king, however, was not satisfied; and, at the instigation of some of his advisers, he privately despatched a small vessel, with instructions to pursue the route which had been laid down by Columbus. The sailors set forward, but soon lost courage, and returned to Portugal, where they affirmed that the project was impossible and chimerical. Columbus was indignant at this mean attempt to rob him of the fruit of his labours, and he refused to renew negotiations upon any terms with the perfidious king. He left Portugal, and no trace of him could be found for some months. It is supposed, however, that he was employed during this time in placing his scheme before certain of the Italian states; and it is known that he sent one of his brothers to England to lay his propositions before Henry VII. It was an ill time for Columbus when he arrived in Spain. Ferdinand and Isabella were occupied with their enterprise to recover Granada from the Moors, and the wild dreams of a poor man were likely to receive little attention in the bustle and excitement of a camp. Columbus had a bold heart, and armed only with a letter of introduction from the guardian of a convent to the queen's confessor, Fernando de Talavera, he set out for the Castilian court, assembled in 1486 at Cordova. Obstacles met him at the very outset, and he was obliged to recur to his old employment of map-making to procure bread. But his obstinate adherence to the project, and the earnestness with which he discoursed upon it, worked their way, and by degrees his theory was deemed at least worthy of consideration. He obtained an audience of the king, who directed that an assembly of learned persons should confer with Columbus. If he anticipated a favourable decision, he was again doomed to disappointment; for, as much difference of opinion existed, and many errors and prejudices stood in the way, no conclusion was ever come to. For five years did Columbus press his plans upon the king and queen with varied hopes of success; but at length, when he was on the point of quitting Spain for ever, some friends of his, high in office, prevailed upon the queen to promise to undertake the enterprise. At the time when she expressed her determination to pledge her jewels to raise the necessary funds, Columbus was actually on his way to the coast. A messenger was despatched after him, and he hastened back to court. Articles of agreement were at once drawn up, by which it was stipulated that Columbus should hold the office of high admiral in perpetuity, of all the seas and lands he should discover, together with the dignity of viceroy: that he should receive one-tenth of the profits arising from the merchandise and productions of the countries in his admiralty: and that, on contributing an eighth part of the expenses of the expedition, he should receive an eighth part of the profit. It must have been a proud moment for Columbus when these articles received the royal signatures. Let those (says Washington Irving) who are disposed to faint under difficulties in the prosecution of any great and worthy undertaking, remember that eighteen years elapsed after Columbus conceived his enterprise before he was enabled to carry it into effect; that the most of that time was passed in almost hopeless solicitation, amidst poverty, neglect, and taunting ridicule; that the prime of his life had wasted away in the struggle; and that, when his perseverance was finally crowned with success, he was about fifty-six years of age. His example should teach the enterprising never to despair.

The admiral, perhaps, now deemed the prize all but won, and saw in imagination unsummed wealth in his grasp. But at the very outset a fresh difficulty sprung up. In spite of the royal mandate, he could not at first get the vessels assigned to him furnished with men or equipments. There was a superstitious prejudice against the expedition, and every one resolutely refused to doom themselves to a mysterious but uncertain fate. It was by little short of main force that he procured a crew to embark. At length, on the 3d of August, 1492, Columbus weighed his anchor, and set sail with a squadron of three vessels. Their course was first directed to the Canary Islands, where they took in wood and water. When he again set sail and steered westward, Columbus had to soothe the distress of his sailors, who broke out into loud lamentations, and shed many tears on losing sight of land. In order to conceal the full amount of the distance that divided them from their native land, Columbus adopted the stratagem of keeping two reckonings, one of which was accurate and reserved for his private use, the other, showing numbers less than the truth, was exhibited in public. As the vessels advanced, the variation of the needle was noticed, and became a new source of alarm; for such a phenomenon had never before occurred, and it seemed as if the course of nature was diverted in order to prevent this impious voyage. If the compass failed them, how could the ships be guided? However, the sailors were quieted by Columbus' explanation. He said that the polar star did not represent the true pole; and that being a fixed point, not marked by any visible object, the north star moved like other stars around it. Hence the divergence of the needle from that star proved nothing more than the movement of the latter. In this explanation of the phenomenon, which must have given rise to many surmises in the admiral's mind, there is a curious instance of truth and error. After a while they fell in with the trade wind, and were speedily carried along a smooth sea for many days without shifting a sail; but even this was interpreted in an evil sense by the timorous-hearted, for they said, if the wind sat always in that quarter they could never return to Spain. A pension of thirty crowns had been promised to the person who first descried land. Eagerly did the men look out when they came up with patches of drifting weeds, that looked as if they had but recently left a shore; and still more when some little birds flew singing amongst the sails, and cheered their drooping hearts with tidings of land. Still no bottom was discovered on letting out a plummet line. Then the sea became as smooth as a frozen lake, and the ship scarcely made any way.

It seemed probable that they might remain fixed in a motionless ocean, until they perished of hunger and the vessels dropped to pieces. However, a heavy swell soon relieved them from apprehension of any such fate; but being unaccompanied by wind, it was regarded as an ominous portent.

Thus passing from fear to fear, the situation of the admiral amongst a set of men growing daily more stricken by terror and despair, may be conceived as neither happy nor safe. The seamen broke out into audible murmurs, and exclaimed against their commander as one who was ready to sacrifice the lives of others to gratify his own ambitious designs. They even proposed to destroy him, and turning the prows of the vessels eastward, endeavour to seek Spain. A cry of land interrupted this scheme, but the appearance proved to be merely a cloud. For some time other cries of land were raised that turned out as false as the first, and Columbus, to put an end to delusion, declared that if any one gave a notice of the kind which should not be verified within three days, he should forfeit all claim to the pension. Following the counsel of his brothers, and other experienced captains, Columbus altered his course to the west-south-west, to which direction some birds were observed to bend their flight; but no land being met with at the end of the third day after this alteration, open mutiny broke out amongst the crew, which it might have been impossible to put down had not the signs of land become next day indubitable. A carved staff and a branch with berries upon it were seen floating on the water, and the gaze of every one on board was intensely bent upon the horizon. At evening, Columbus addressed his crew, and declared his firm belief that they would make land that very night. When daylight had disappeared, he stationed himself on the high poop of his ship, and anxiously watched for the faintest indications of *terra firma*. About ten o'clock, he perceived all at once a distant light; but afraid of being the dupe of an optical delusion, he pointed in that direction to one of the crew, inquiring if he observed anything, and the man answered, that he saw a light. After a few gleams it disappeared; the vessels, however, continued their course, but at two in the morning a gun from one of the other ships announced that land had really been discovered. Orders were immediately given to take in sail.

That the admiral's mind, in spite of his calm temper, was racked by excitement, and expanded to an intense degree by the glory of his achievement, may be readily conceived. However long he might think the day in coming, it came at last; and he then saw a level island some leagues in extent, to which he gave the name of St. Salvador. After having taken possession of it in the name of Ferdinand and Isabella, he proceeded to the southward in search of some land, to which he imagined the natives pointed, in answer to inquiries after gold; but after cruising for some days amongst a number of fertile islands, now known as the Bahamas, he sailed to Cuba, the largest island of those seas. A large portion of the coast, and part of the interior, having been explored, and still no precious metal having been discovered, Columbus sailed towards some high mountains, which he descried from a great distance through the transparent atmosphere of the tropics. These proved to belong to an island which he named Hispaniola, now known as Hayti, or St. Domingo. The Spaniards were delighted with the splendid scenery, and the luxuriance of the soil, and they established friendly communications with the natives. The admiral's ship being wrecked on the coast, the greatest hospitality was shown to himself and his crew. Another of his ships having been lost sight of for some time, and the remaining one being much too small to contain his men, Columbus determined upon building a fort, in which he could leave a detachment, whilst he returned to Spain for assistance. The fort was built, and placed under the command of Diego de Arana. Columbus then set sail, and soon afterwards met with the missing ship, with which he proceeded on his return voyage; however, a violent storm again separated them, and Columbus first succeeded in reaching land. Another storm drove him upon the Portuguese coast, whence he deemed it his best policy to visit the king at his capital, before going to Spain. The reception he met with from Ferdinand and Isabella was splendid, and his journey to their coast was said to be like the progress of a sovereign. The inhabitants poured out of their houses to greet him, and the air rang with acclamations. When he entered Barcelona, where the sovereigns were then residing, he disposed the Indians he had brought with him, together with specimens of the animals, plants, and mineral productions of the islands he had touched at, into a procession which moved in solemn order from the gate to the royal throne, where he was received as if he were a personage of the highest rank; nay, he was commanded to take a seat—a most unusual honour at a punctilious court. He then narrated his adventures, which were listened to with astonishment; and, at the close of his discourse, the king and queen sank on their knees and gave God thanks, which act was followed by the chanting of the Te Deum anthem. During his stay at court, Columbus was the recipient of many marks of distinguished favour; and a second expedition was ordered to be immediately fitted out. In order to reap the full benefit of the discoveries, the Pope was applied to, to exercise his authority as disposer of all heathen lands, and to bestow the newly discovered territories upon the crown of Castile. Very large grants had already been made by his holiness to the king of Portugal, in respect of discoveries in the east; but it was thought that no difficulty could arise, if all lands to the east of an imaginary line drawn from the north to the south pole, a hundred leagues west of the Azores, should be confirmed to the Portuguese; and all lands to the west of that line discovered by the Spaniards, should be ceded to them. The possibility of the two powers extending their conquests until they met, does not seem to have been contemplated by the occupier of the papal chair.

Having thus traced with some minuteness the incidents of Columbus' career up to the termination of his first voyage, we must now be more brief, as our chief object in writing this paper was to call to mind the great difficulties of the first navigator across that ocean, which is now so readily traversed, to the skill and perseverance with which they were overcome, and to the commanding genius of the man who conceived the possibility of such an exploit, and conducted it to a successful issue. On the 25th September, 1493, Columbus again embarked for the Indies, but in a style very different from that in which he set forth on the preceding expedition. Seventeen ships and fifteen hundred men accompanied him—the difficulty, on this occasion, being not to obtain a crew, but to prevent the ships from being overburdened. The fleet touched at several of the Caribbean islands, which had not been previously visited, before it arrived at Hayti, where the whole crew expected a joyful meeting with the Spaniards who had been left behind. Judge of their consternation when they found the fort levelled with the ground. It appeared that, soon after Columbus had sailed, they had disobeyed his injunctions, had quarrelled amongst themselves, and with the natives, of whom an army attacked them, and the whole establishment had gone to wreck and ruin. Another place was selected, and Columbus named the new city Isabella. Having then made an excursion into the interior, and opened up some mines, in the neighbourhood of which he built a fort, he sailed with these vessels to Cuba, and, in the course of the voyage, visited Jamaica. He returned in a state of complete exhaustion, both in body and mind, and when sensibility was restored, he was mortified to find that the affairs of the settlement, during his absence, had again fallen into confusion. A reinforcement having arrived from Spain, Columbus determined to give battle to the Indians, who had assembled in great numbers. An engagement ensued, wherein thousands were slain, and the victory was followed up by the imposition of tribute. Meantime, the complaint of those persons whose hopes of reaping wealth and enjoyment without labour of any kind, had been grievously disappointed, had found their way to Spain, along with accounts of what all had suffered from sickness and fatigue. The sovereigns were advised to send out a commissioner to inquire into the proceedings, and Columbus returned to the old world with him, in 1496. Nothing came of the investigation, but the admiral suffered great delay before he could again put to sea, which he did in May, 1498, with a squadron of six ships. The first land they reached, after crossing the Atlantic for the third time, was an island, to which he gave the name of Trinidad; then passing to the coast of the American continent, which he now saw for the first time, where he remained until his stores were almost exhausted, he sailed to Hayti. There fresh anxieties awaited him, for conspiracies had been formed, and a rebellion had broken out, against the authority of his brother, whom he had named lieutenant-governor, He endeavoured, in vain, to retrieve matters; and whilst he was kept busy, his enemies at home were undermining his reputation. So many grievances were complained of, and his actions were so misrepresented, that a commissioner was again directed to proceed to the Indies, and investigate his conduct. The commissioner, on arriving at Hayti, assumed the command of the colony, and had the audacity to put Columbus in irons. Thus shackled, the admiral was sent to Spain, where his disgraceful treatment excited universal indignation; and Bobadilla, the commissioner, was immediately superseded by Ovando, who set out to assume his office with a fleet of thirty ships, whilst Columbus was permitted to sail on a fourth voyage, but with a squadron of only four small vessels. This was in May, 1502, when he was sixty-six years old. He touched at Hayti, and then bore away towards the continent, with the view of searching for a strait which led, he imagined, somewhere about what is now termed the Isthmus of Darien, into the Indian sea. After beating about the coast for many weeks, he landed at Veragua, near which place he understood there were rich mines; but the natives, by repeated attacks, effectually prevented him from making a settlement, as he wished, and he was obliged to turn eastward to recruit his crew, and refit his shattered vessels at Hayti. A storm overtook them, and they were fain to run them aground on the coast of Jamaica. There he was confined twelve weary months, before

he was released by ships sent by the commissioner Ovando, who, impelled by sinister motives, had refrained from despatching assistance, until some time after he had heard of the admiral's distressed condition. Columbus did not remain long at Hayti; the treatment he experienced was little flattering to him, and he could ill bear to see exercised a cruel and tyrannical rule over the Indians. In November, 1504, he was once more in Spain; and within a few days of his arrival, his patroness, the Queen Isabella, died. Columbus employed every means in his power to be reinstated in his original situation, as viceroy of the Indies, but his petitions were treated with coldness and evasion. His latter end drew nigh, before any final reply had been given to his earnest requests; and, on the 20th of May, 1506, this great man expired, after a life chequered, in an extraordinary degree, by glory and misfortune, but leaving behind him—

"Victorious name, which never will be dead."

It remains only to say, that his body was deposited, soon after his decease, in a convent at Valladolid, whence it was subsequently transported to a convent at Seville. In 1536 it was removed to Hayti, and on the cession of that island to the French, it was again disinterred, and deposited, with great solemnities, in the cathedral at Havanna, in the island of Cuba. The remains of most men are buried but once; the corpse of Columbus, however, was interred as often as the living man had voyaged across the Atlantic Ocean. May it now rest in peace.

SOME ACCOUNT OF THE SOUTH AUSTRALIAN COPPER MINES.

By J. H. Kershaw.

The mineral resources of South Australia appear inexhaustible, while the richness of the ores, and the facility with which they are obtained, have marked this province as one from which we may expect to receive considerable supplies of copper. In fact, so enormous has been the increase in the shipments of this commodity, that the value of copper ore exported to Swansea, during 1846, was £151,786; while the amount, during 1845, was only £14,874; and during 1844, the insignificant sum of £4,009.

The principal South Australian copper mines are the Burra Burra, the Kapunda, the Montacute, the Kanmantoo, and the Princess Royal. Many more might be mentioned; but as yet, little or nothing has been raised from them, owing to the scarcity of labour, the want of sufficient capital, and occasionally the poverty of the indications of ore. The distinguishing feature of nearly all these mines is, that the deposits of copper are not only visible at the surface, but, on penetrating into the soil, the lodes become more defined, while they improve both in quality and quantity; so that, in South Australia, it is not considered an unfavourable symptom (as in this country) when the ore approaches the surface. Sometimes the mineral deposits are found in large bunches, which merely require quarrying and sorting, after which the ore is ready for shipment: the assay, however, of this kind, is lower than that from regular lodes.

I. The Burra Burra Mine was discovered in September, 1845, in a locality about ninety miles to the north-east of Adelaide. The mineral indications having been very decided, a few of the monied colonists determined to obtain a special survey, comprising 20,000 acres of the district. Accordingly, that extent of land was purchased from government for £20,000—one-half of which became the property of the South Australian Mining Association; the other half, that of the Princess Royal Mining Company. The Burra Burra Mine, which belongs to the former, was opened in September, 1845, and worked with extraordinary spirit; so that, previously to the 31st March last, during a period of eighteen months, 9,841 tons of ore had been raised; 6,034 tons of which had been sold at, or shipped to, Swansea, and the rest (3,807 tons) remaining in the colony, ready for transmission to England. The process of smelting had not been adopted in the case of the ore then exported; but in the Second Annual Report, presented to the shareholders last April, it is stated, "that the smelting works are so far completed, that operations will commence in a few weeks." Bearing this fact in mind, we are not surprised at the assays varying considerably; latterly, however, the ore sent for sale has been selected with greater care than that of the first few parcels, and consequently yielded a much higher produce. The total amount realized at Swansea for 4,657 tons, which were sold from the 8th July, 1846, (when the first consignment was offered) to the 4th November, 1847, has been £94,727 18s. 6d.—the highest price £32 13s. per ton, the lowest £10 16s., and the average £20 6s. per ton. The working expenses—that is, the cost of raising the ore—from September, 1845, to April, 1847, were £37,418; while the charges for carting the ore from the mine to Port-Adelaide amounted to £26,770—the distribution of which, in the shape of wages, has materially benefited the labouring population of the colony. The number of persons connected with the mine, or resident at the adjoining township of Kooringa, in November, 1846, was 550, and these comprised miners, sawyers, carters, mechanics, and other labourers.

The South Australian Mining Association was originated entirely in the colony. Its subscribed capital is only £12,320, represented by 2,464 shares of £5 each, and the management of the affairs is vested in a Board of Directors, who periodically retire from office.

Soon after the Association had commenced operations, the shares became saleable at £100 each, at which price the proprietors were not anxious to make transfers; but owing to the receipt of unfavourable intelligence from Swansea, as to the value of the first few cargoes of ore, the shares could be obtained at £45 premium; yet, notwithstanding this circumstance, the subsequent shipments so much improved that the shares rose again to their former value. The Directors, in their last Report, dated 21st April, 1847, stated that, from the profits on the sale of 1,757 tons of ore, they intended shortly to declare a dividend at the rate of fifty per cent. per annum! Such a measure, we have reason to believe, will be adopted. The total expenses, both in the colony and in England, chargeable on the above quantity of ore, amounted to about £12 per ton, and its average value was £17 per ton; so that the profit derived would be £5 per ton—a sum quite sufficient to pay a very large dividend on the capital.

It is unnecessary to adduce any additional facts, in order to prove the extraordinary productiveness and immense value of this mine. It has, undoubtedly, not only benefited the shareholders, but the province at large, by affording employment to a considerable number of persons, whose labour has developed the extent of riches existing in a locality which promises to supply the British market with copper for years hence.

II. The Kapunda Mine, situated forty-five miles north of Adelaide, consisted originally of an eighty acre section of land, which was purchased by Messrs Bagot and Dutton, at the upset government price of one pound per acre, and on which the workings were commenced in January, 1844. In the following year 100 acres more were purchased; but owing to competition, it cost the large sum of £2,210; yet, in a short time, the owners raised sufficient ore from this portion of land to defray the outlay. The sales of copper ore from the Kapunda Mine, comprised, in—

1845,	252 tons, which realised	£6,225	0	0
1846,	831 " "	16,726	1	6
Aud to October.....1847,	1,098 " "	20,298	15	6

So that the total quantity of ore sold, from the commencement of the operations to last October, has been 2,181 tons, for which £43,249 17s. was paid, showing an average of £19 10s. per ton. Although the assay of this ore is less variable than that of the Burra Burra Mine, it has brought, in one instance, £30 7s. 6d. per ton, while none of it has sold under £15 per ton; the general price bringing from £18 to £24 per ton.

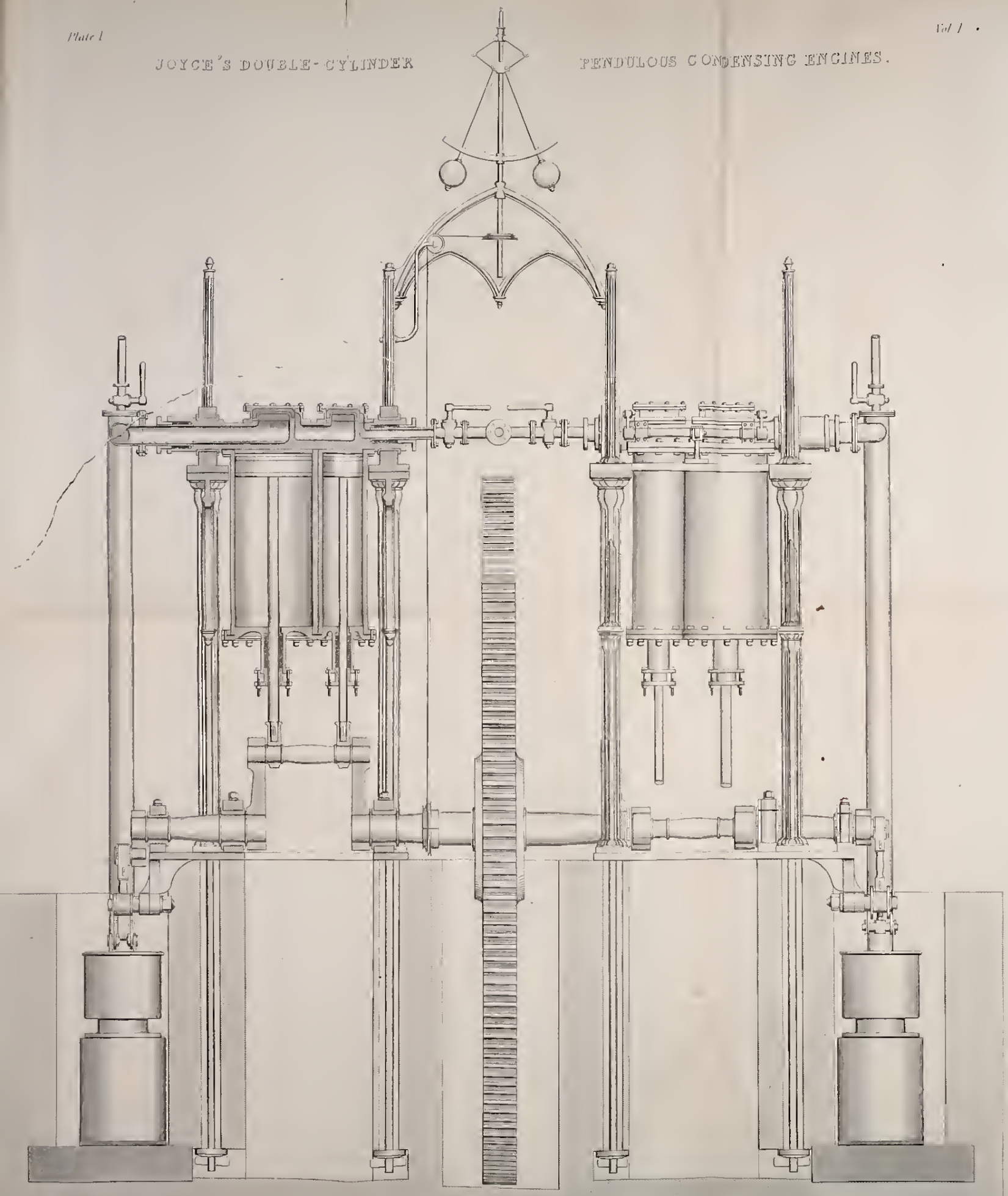
During 1844, 116 miners were employed, and the following year that number was nearly doubled; but at the commencement of the present year, some of the workings were temporarily delayed, by the shafts becoming filled with water to such a depth as to require machinery to empty it. A steam-engine having been ordered from England, the application of which would effectually remove the water, the operations will again be vigorously prosecuted.

The ores raised from this mine are principally the carbonate, hydrocarbonate, and sulphuret, with occasionally small portions of muriate of copper and malachite; some of the latter has been polished, and made into brooches. These ores, as well as most of those from South Australia, are very fusible, contain little sulphur, and produce fine metal; they are, consequently, much valued at Swansea; and in order to combine with ores of a harder nature, generally realize a price greatly beyond the worth according to their assay.

A specimen of acatamite, from the Kapunda Mine, has been presented to the British Museum, the weight of which is about 20 lbs. It is the only mineral of that kind in the institution.

III. The Montacute Mine, distant about ten miles from Adelaide, now belongs to a company whose paid-up capital is £5,000, and whose property consists of 640 acres of land. Immediately after its purchase in February, 1844, the working was commenced, so that, during the following year, 331 tons were sold at Swansea, realising £4,548 10s.; during 1846, 210 tons, realizing £3,576 1s.; and to November, 1847, 55 tons, realising £1,029 18s. This statement, therefore, shows an average of £15 7s. per ton. Double the above quantity had been raised, but which, we presume, will not be shipped until smelting be adopted, or freights reduced, as the heavy expense of sending it to England, and subsequent charges, form a serious drawback to the operations of this mine; and whether the ore be rich or poor, the cost of raising, cartage to the port, and freight, &c., remains just the same. Indeed, the fact of

JOYCE'S DOUBLE-CYLINDER PENDULOUS CONDENSING ENGINES.



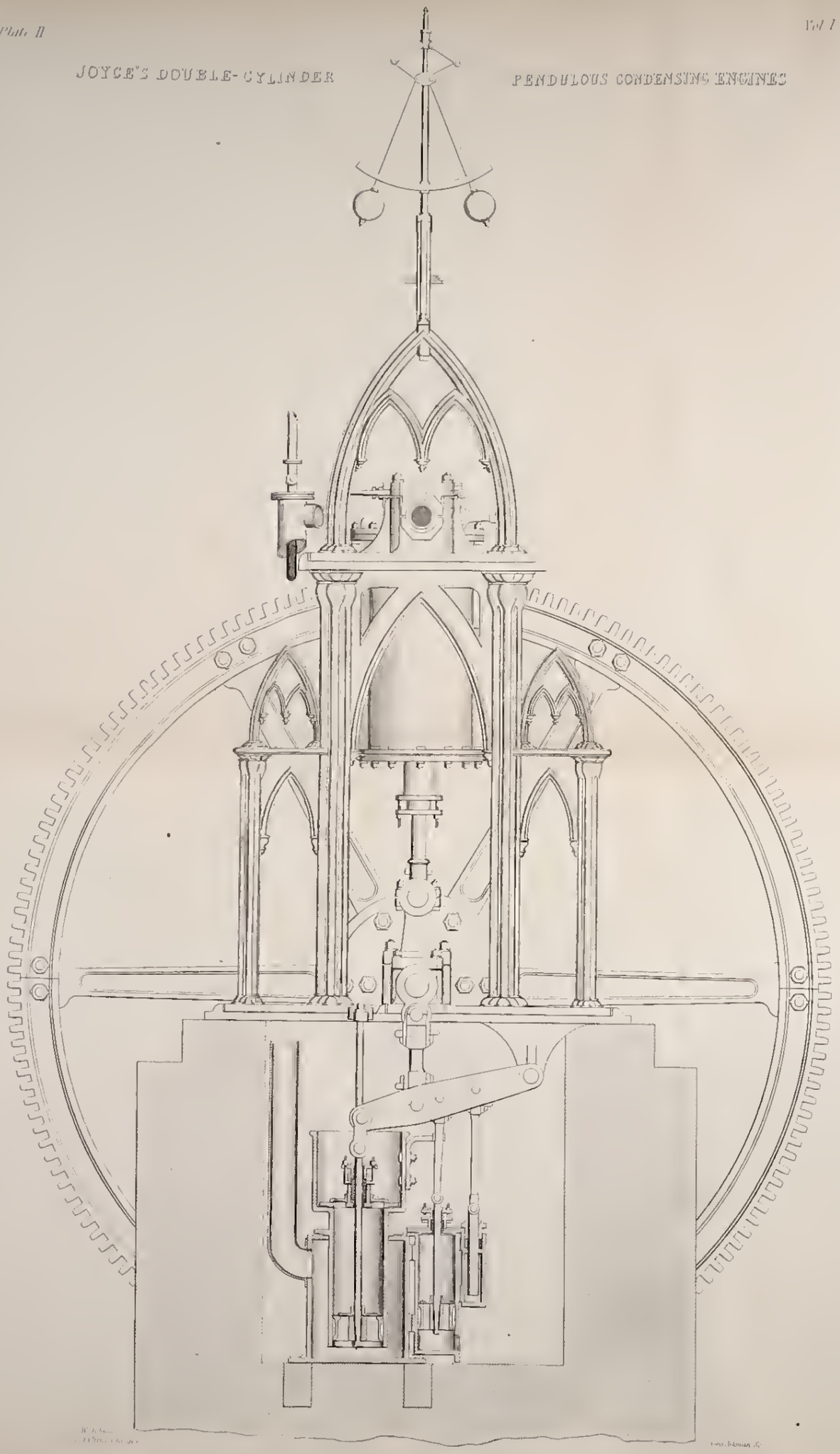
W. Johnson
Patent Office Library

Geo. Johnson Sc.

Scale

Feet

JOYCE'S DOUBLE-CYLINDER PENDULOUS CONDENSING ENGINES



Scale

the sales of ore having greatly diminished since the first years' working, renders it questionable whether the Montacute Mine does yield a sufficient return to induce the proprietors to make extensive shipments.

The ore raised is chiefly of the same kind as that from the Kapunda Mine, with the addition, however, of the description called pyrites, and peacock ore. The mineral is embedded in a hill of the clay-slate formation, where the workings have been carried on to the depth of ten or twelve fathoms.

IV. The Kanmantoo Mine belongs to the South Australian Company. The property is situated in the Mount Barker district, about thirty-six miles from Adelaide, and comprises 12,000 acres of land, which, as part of a special survey, were purchased at the minimum price of £1 per acre, in November, 1845. The mine was opened in the following month, and since that period about 600 tons of ore have been raised, 440 tons of which were shipped in the course of eighteen months. Of the latter quantity, 295 tons have been sold, and realized a gross sum of £4,338 17s. This amount exhibits a rather low average; but as the ore was taken from the surface, and as the general characteristic of the South Australian mines is, that the lodes become richer in proportion to the depth of the workings, we confidently believe that future consignments will yield a more favourable produce. The operations are carried on by sinking shafts, in one of which a lode of copper has been found, twelve feet wide, and of fine quality. A considerable quantity, however, of the ore brought to the surface, has been of an inferior nature, which has not been shipped, owing to the high freights; but by the last advices from the colony, smelting was shortly to be adopted at this mine—a measure which will greatly enhance the profits derived from the property.

V. The Princess Royal Mine follows next in importance (so far as already ascertained) to the Kanmantoo Mine. It is situated on the southern moiety of the survey, consisting of 20,000 acres, of which the South Australian Mining Association possesses the northern portion. The capital of the company (£20,000), divided into 400 shares of £50 each, is paid up to the amount of £11,746, with which the property was purchased from the original owners, and formed into a company in October, 1846. Although the indications of ore were promising, the workings have been conducted on a very limited scale, so that only about 200 tons have been shipped, of which 60 tons have been sold at Swansea, and realized £1,221 15s., being an average price of more than £20 per ton.

The facility with which the Burra Burra and Kapunda ores were raised, their richness and abundance, gave an erroneous idea as to the expense of working, and the profits derivable from the other South Australian mines, whose value has not yet been ascertained, while many of them exist only in name, or in the imagination of the sanguine proprietors; and, consequently, several parties purchased mineral land at exorbitant rates, without calculating that the cost of obtaining the ore, rendering it fit for the English market, and sending it thither, would vary according to the nature of the soil in which it was imbedded, the wages of labourers, and distance from the port of shipment, exclusive of other charges incident to mining undertakings.

Those who are desirous of procuring more detailed information relative to the mining interest of South Australia, should consult Mr. Dutton's work.* from which we have taken the liberty of collecting some of the statements that appear in our notice of the Kapunda and Montacute Mines. A considerable part of the book is devoted to an account of the mineral districts of the colony, the importance of which, in connection with supplying India and China with copper, will, in course of time, render it a most valuable British dependency.

JOYCE'S DOUBLE CYLINDER PENDULOUS CONDENSING ENGINES FOR MANUFACTURING PURPOSES.

Illustrated by Plates 1 *and* 2.

The engines which we have engraved for our illustrations this month, are accurate copies of a pair erected by Messrs. W. Joyce & Co., of the Greenwich Iron Works, at the Bone Mills and Patent Manure Manufactory, Deptford, the property of J. B. Lawes, Esq., to whom we are indebted for permission to make them public. The peculiarity of their construction results from what we may term a combination of two different principles —the double cylinder of Woolf, and the oscillating cylinder of Witty.

The arrangement before us differs from the oscillating double cylinder marine engines, constructed by the same firm, in the mode of suspension of the cylinders. The engines of the Thames steamers, the Ant, Bee, and Cricket, for instance, have oscillating cylinders with central trunnions, similar to those of the Messrs. Penn. But, in order to adapt the Woolf oscillator for manufacturing purposes, Messrs. Joyce have placed the trunnions at one extremity of the cylinder which is inverted, so as to work after the fashion of a pendulum; hence the name.

Plate 1 is a front elevation of the pair of engines; one engine being in section, for the purpose of explaining the internal mechanism. Plate 2 is a side view corresponding, showing the position of the air-pump and condenser. The drawings are sufficiently clear to afford their own explanation, as the action of the steam is precisely the same as in the ordinary Woolf's engine. The steam, of 40 lbs. pressure, is first conveyed to the small, or high pressure, cylinder, upon the piston of which it acts in the ordinary manner; the partially expanded steam is then discharged into the large cylinder, the content of which is four times greater than that of the former. In this cylinder the steam acts expansively, in conjunction with the vacuum in the condenser; thus the expansion is carried on in the most gradual manner, the resulting motion being much more uniform than when a single cylinder only is employed. An examination of Plate 1 will show that the nozzles of both cylinders are cast in one piece with the trunnions; and to the under side of this casting, the pair of cylinders are firmly bolted, the valves and valve-chests being on the top. Thus arranged, the use of an eccentric rod is dispensed with, as the angular motion of the cylinder works the valves. The cross-beam connecting the upper side-frames, carries a short pillar with a fixed stud, which is passed through a short slot in the extremity of a lever fast on a rocking shaft working in bearings on the top of the cylinder. This shaft, again, carries two side-levers connected by links, with the cross-head of the valve-spindles. In this way, as the cylinder oscillates, the fixed stud allows of the horizontal motion of the slotted lever, but prevents any vertical movement; and thus the valve is worked in a simple and elegant manner. The situation of the centre of motion of the cylinders may be said to be advantageous, in respect that the pressure on the piston acts upon the crank at a more effective angle than when the cylinder oscillates upon central trunnions. The connecting passage for the steam, between the two cylinders, being cast in the solid metal of the nozzles, little loss can ensue from condensation by the action of external cold.

The condensers are copper tubes of large diameter, into the upper ends of which the injection water is conducted, so as to come in direct contact with the waste steam from the large cylinders. The simplicity of this apparatus is one of its least valuable features, as the condensation is effected in the most rapid manner. A plan of the engines, as well as elevations of the mill-gearing, and grinding apparatus, will be given in our next Part.

The engines are of a collective power of 40 horses, and their consumption of fuel is, we believe, somewhat less than 3 lbs. of coal per horse power per hour.

PAPERS ON ELECTRICAL SCIENCE.

By Mr. R. Smith, Blackford.

At the head of the voluminous list of electrical discoveries of the eighteenth century, stands the ever-memorable one of the identity of atmospheric electricity, and the artificially produced fluid of the electrical machine by Franklin. This eminent investigator had, long previous to his complete realization of the fact of the connection, held the as yet unconfirmed theory of their relation. Dalibard, being aware of this idea, is said to have acted upon the hint, and to have succeeded in drawing down sparks from the clouds of heaven, at Martly-la-Ville. Whether this affirmation is true or not, it is certain that Franklin carried on his researches in ignorance of the pursuits of his brother philosopher; and, as all the world knows, with the most complete success, in the substantiation of his preconceived views. Nothing could be simpler than the apparatus he employed, and his proceedings afford us an eminent example of the independence which master-minds exhibit, in regard to the simple extraneous details of their investigations.

A silk handkerchief extended over two crossed sticks, in imitation of the kites of our school-days, with a short pointed wire on the standard as a conductor, was all he required to put his ideas into a practical form. This extempore contrivance being raised in the atmosphere in the usual manner by a cord, to which a short hand-line of silk, with a key at the junction, was attached, the experimenter patiently awaited the result. For a considerable time no signs of the approach of the electric fluid were perceptible; his heart sunk within him, and he was on the point of relinquishing the trial in despair, when a cloud passed over the kite, and the fibres of the cord, ever telegraphic of the approach of the subtle fluid, began to diverge. Presenting his knuckle to the suspended key, the well-known electrical evidence, the spark, directly passed. The passing shower, moistening the cord, permitted the continuous passage of the

* South Australia and its Mines. By F. Dutton, Esq.

current to the key, whence he gathered a supply, and with it performed all the experiments usually attempted with the artificial lightning.

This beautiful demonstration was not long in attracting the notice of contemporary European philosophers, more especially M. de Remas, Cavallo, and Professor Richmau. The prosecution of a series of these experiments by the latter-named gentleman, ended fatally for the operator. He had unwittingly set up a lightning conduetor on his house, without taking the essentially necessary precaution of providing a discharging outlet for the current; and the result was, that upon going near the conductiug-rod, at the time that it was powerfully electrified, he was instantly struck dead by a lightning stroke. The apparatus he employed was nothing more than a common Leyden jar, communicating with an iron rod, passing perpendicularly up through the roof to a height of five feet.

The eminently valuable researches of Becquerel, Breschet, Crosse, Weekes, and others, have furnished us with a variety of contrivances for the determination of the electrical state of the atmosphere. These instruments are termed acrial electroscopes; and investigators have ascertained, by their aid, that when the atmosphere is clear, its electricity is invariably etole or positive; that a larger quantity is present in winter than in summer, and that its intensity is greater during the day thau at night; that its maximum occurs between seven and eight in the morning, and its minimum hetween one and two in the afternoon; that it again increases as the sun declines, until sunset, when a diminution again occurs, and it remains feeble throughout the night.

We often ohserve the sky clear as a polished mirror, without a solitary speck to dim its ethereal azure, gloriously illuminated by the blaze of the sun; on a sudden, a single minute spot appears rising ahove the sharply defined horizon; gradually it increases from a barely visible point, until it exposes to our view a dense mass surrounded hy tiers of white woolly clouds, and ever and anon an electric flash darts from the dark dismal mass, sometimes in the shape of a star, and theu again under the form of an acute angled zig-zag line. Each flash, as the field of strife nears us, is followed hy an artillery-like report; the whole face of the landscape assumes a sickly yellowisb huc; the sky is gradually hid from view hy the dense cloudy covering; and the rain and wind appear to give battle one to the other. A summer storm of this nature often clears away after a short time, the cracking explosions gradually diminish in loudness and frequency, nature again resumes her beauteous robes, aud her auimated tenants rejoice at the cease of the warfare. Here we have a faint picture of the truest example of the most electrical state of the atmosphere.

Generally speaking, in thunder storms, two clouds are in different states of electricity; and consequently, when tbey happen to approach pretty near each other, a discharge, occasioning a flash and report, takes placo. This result is analogous to that ohtaiued from the coatings of a Leyden jar; the spark and report in the latter case, altbough produced from a very few square inches of surface, are sufficiently great to lead us to form an idea of the wondrous effects to he expected from square miles of electrified cloud surface. These electrical discharges evidently dissipate tho electricity of the atmosphere, and the clouds are condensed into rain.

Different strata of air are differeutly electrical, and we are enabled on these grounds to accouut for the vesicular nature of clouds, as they interpose themselves between atmospheric strata in different states of electricity, aud are arranged in such a position as to cause a mutual discharge. If tbe cloud comes within striking distance of the earth, the discharge takes placc between the cloud and the earth; but if the distance between the two is too great for the intensity of the accumulated electricity, the fluid escapes silently to the earth, every flash that reaches the ground being regularly distributed over its surface, particularly over the antipodes of the locality where the storm has occurred.

During a storm, it frequently happens that a numher of simultaneous zig-zag flashes are observed, stretching to au extent of several miles. These appear to be produced by a series of discharges from the one cloud to the other; these clouds serving as intermediate conductors of the electrical energy. Tbough the flashes occur at the same time, the difference in their distances from us, causing the sounds to reach our ears in succession, produces the rumhling noise, which, increased hy reverherations from surrounding objects, amounts to what we term thunder.

The proximate causes of the presence of free electricity are various, as the change of temperature, the composition and decomposition of substances, and evaporation. The production of free electricity by evaporation, is capahle of proof in many ways. If a small metallic cup of water is placed on the cap of an electrometer, any red-hot hody, as a cinder, dropped into it, will cause a divergence of the gold leaves with *etole energie;* a slight addition of acid to the water in the cup, will, under the same circumstances, cause an indication of the presence of *pinceau energie.*

The fire of St. Elmo, with which so many of the superstitions of past ages are connected, is a very curious electrical phenomenon. It is often observed at the summits of the masts of ships, and on the points of spears, during a march of soldiers. The peculiar lambent hlaze, and the almost supernatural creeping aud flitting attending it, rendered it a fair object for the consideration of believers in omens, as predictions of dire events. Travellers, on ascending high mountains, have often observed extraordinary electrical phenomena, such as the standing on end of the hair, and the production of buzzing sounds from the tips of their fingers, on touching each other. Dr. Hooker once observed these effects during a fall of snow on Ben Nevis: his hair stood erect on his head, and electricity appeared to flow from the stones around, hissing as it came.

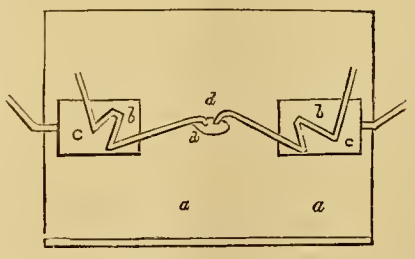
There is strong presumptive evidence that the phenomenon of the aurora borealis, or northern lights, is in some measure connected with electricity. The beautiful appearance of this play of light may be imitated in a very clear manner, by passing a current of electricity through a partially exhausted glass tube, the undulatory motion and glow of colours being very similar to the atmospheric appearance.

Mr. Rowell is of opinion that the dry air in the frigid zones, during intense frosts, being a non-conductor, insulates the electric clouds, and the electrical fluid flashes back through the higher and rarified air to the more temperate regions, thus producing the phenomena of the aurora.

To Dr. Priestley we are indebted for the earliest investigations as to the chemical effects of common electricity. He discovered that an electric spark, passed through an infusion of litmus, changed the blue tint of the liquid to red. This peculiar effect was explained by Cavendish in 1784, who showed that the electrical influence caused the oxygen and nitrogen of the atmospheric air, confined in the tube containing the liquid, to combine chemically, forming an acid, which produced the change of colour. In 1780, the several philosophers, Dieman, Paetz, Van Troostuyck, and Cuthbertson, decomposed water by electrical shocks. The water was contained in a glass tube, into each end of which a gold wire was inserted, the extremities of the wires being made to approach within five-eighths of an inch of each other, in the interior of the tube. At each shock, bubbles of its constituent gases, oxygen and nitrogen, were evolved from the water. Subsequently, Dr. Wollaston published a method of decomposing water by sparks instead of shocks: his invention consisted in the reduction of the surface of communication, in proportion to the intensity of the electric energy employed.

Dr. Faraday has invented a simple and clever arrangement for evolving the gases by means of frictional electricity. Fig. 1, of our woodcuts, represents this plan. *a a*, is a glass plate, upon which two slips of tinfoil, *b b*, are placed. Two pieces of platinum wire, *c c*, are bent, so as to rest upon the slips of foil, their extremities or decomposing poles, *d d*, being placed close to each other on the glass plate. A drop of hydrochloric acid, tinted blue by sulphate of indigo, is let fall upon the points, *d d*, so as to immerse them. One of the slips of the foil is then connected by an insulated wire with the etole, or prime conductor of an electrical machine, and the other with the pinceau, or discharging train. The machine being put in motion, a current of electricity is transmitted through the liquid, and chlorine is evolved. If a drop of a solution of hydro-iodide of potassium, mixed with starch, is applied instead of the hydrochloric acid, iodine will be liberated, and will combine with the starch, producing a blue colour; and if sparks are passed over paper, wet with a solution of hydro-iodide of potassium, iodine is evolved. When a solution of a metallic salt is employed, as the sulphate of copper, or chlorate of tin, the current will precipitate the metal; in like manner, moistened litmus paper is turned red. In this instance, however, the change results from the formation of nitric acid from atmospheric air. Dr. Faraday found that, by moistening litmus paper in aqua potassa, and subjecting it to a succession of sparks over the length of the paper in the air, the acid became neutralized, and formed nitrate of potassa.

Fig. 1.



After the discovery of the Leyden phial, electricity was successfully employed as a remedial agent for the cure of various diseases, by many eminent men, as Drs. Halde and Priestley, Mr. Lovet, and the Rev. Dr. Wesley. The result of the experiments of individuals of such

high repute, offered a ready means of speculation for adventurers. Hence, quacks trumpeted forth the value of electrical applications as a remedy for every known disease. Numerous failures ensued, and the system fell into disrepute; but of late years it has been proved to be of great service in the cure of paralysis, St. Vitus' dance, contractions of the limbs, rheumatism, impaired vision, and certain kinds of deafness. Common electricity is administered in various ways: by the transmission of shocks, which is the most powerful and painful method—by drawing sparks from the etole conductor—or by placing the patient on an insulated stool, and taking sparks from him by means of a metallic ball. Of all the systems, the most gentle application is that of a stream from a piece of pointed wood, brought into contact with the conductor of the machine.—It is difficult to give any idea of the extreme velocity of electricity; but some faint impression of it may be conceived, if we reflect, that the greatest speed of matter which can be produced by art, appears completely at rest when compared with the motion of this subtle fluid. If we take a circular piece of pasteboard, the face of which is coloured in three several sections—red, blue, and yellow—and cause it to revolve with the greatest attainable rapidity, it will appear white. The rapidity of the motion does not give the eye time to observe any one of the three constituent colours of light; they are, consequently, blended together, so as to produce white; but if this card is illuminated, during its revolution, by an electric spark, it appears to remain stationary, and each colour is seen perfectly distinct from its neighbour. The speed of light is 192,000 miles per second; but this rate of motion sinks into insignificance when compared with that of electricity, which is supposed, by some philosophers, to pass through a metallic wire at the rate of 576,000 miles in a second; but it is very doubtful how near we may be to the actual result. Let us consider, for an instant, the vast size of the planet we inhabit —7,912 miles in diameter; yet it is but a drop in the great ocean of the universe, and a current of electricity would wing its way round it in less time than we could pronounce its name.—The luminous effects of electrical light have been exhibited, in a beautiful manner, by an apparatus termed the diamond jar. Fig. 2 represents this jar. The diagonal lines are pieces of diamond-shaped tinfoil, placed in stripes round the jar, inside and out. When discharged, the scintillations of light are most brilliant. The electric diadem is another striking illustration of the same effects. It consists of a leather belt, upon which are pasted a series of diamond-shaped pieces of foil, similar to those used in the jar. To put this belt in action, the experimenter stands upon an insulated stool, with the belt round his head, and holds in his hand a chain connected with an electrical machine in action; another party, standing on the ground, now touches the belt with his finger, when the foil presents the appearance of a wreath studded with diamonds. The illuminative effects of electricity may also be elegantly represented, by placing a number of eggs in a stand, as shown in fig. 3. When a current of electricity is sent through them, the whole of the interior of the eggs appears beautifully lit up.—The discovery of the identity of electricity and lightning, has led to one of the most valuable inventions of the present age —the lightning-conductor. Fig. 4 represents a small apparatus, termed

Fig. 2.

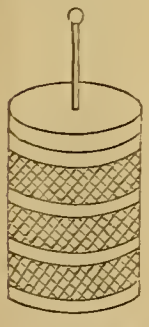


Fig. 3.

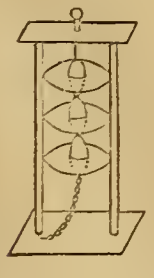
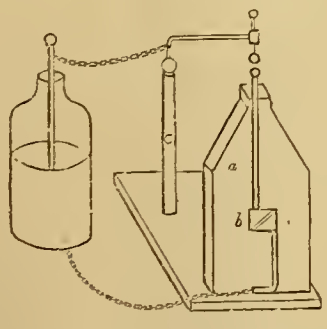


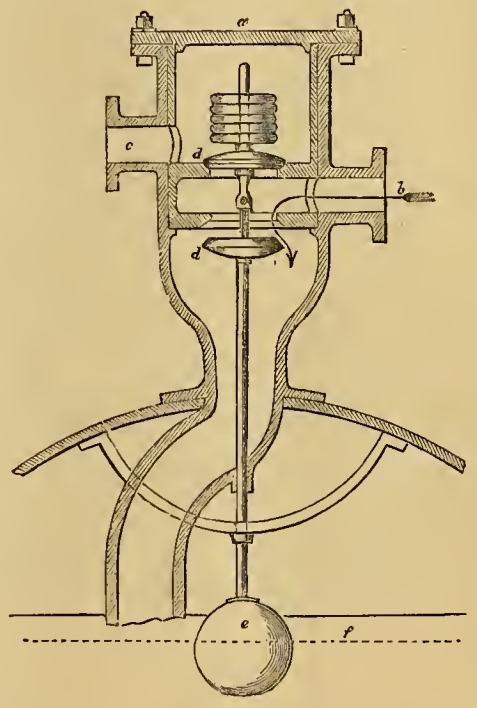
Fig. 4.



the thunder-house, which will explain the rationale of this application. *a*, Is a board representing the gable of a house, having in it a hole, *b*, an inch square, filled up with a piece of wood, with a brass wire fixed diagonally upon it. Another wire is placed upright upon the gable, and is terminated by a ball; a similar wire descends from the hole in the gable, and is attached to a chain communicating with the outer coating of a Leyden jar. A glass pillar, *c*, is loosely fixed in the bottom board of the apparatus, so as to be capable of motion on its axis. The glass pillar carries on its upper extremity a crooked wire and ball, and a chain connects the ball and nob of the jar. When the jar is charged, the glass pillar is moved round, until the ball it carries is above the one on the gable, when a discharge will take place, and the spark, in its passage, will throw the wire in the hole, *b*, from its place, producing an imitation of a stroke of lightning on a small scale.

NEW FEED APPARATUS FOR STEAM BOILERS.

The burning and exploding of boilers is of sufficiently alarming extent, to call for all our ingenuity to amend the evil, and may afford me an excuse for troubling you with the accompanying sketch of a new self-acting feed apparatus, as a movement in the direction of greater security to steam-boat and locomotive-carried travellers, as well as the more directly engaged operatives connected with propelling machinery.



The view I enclose, is a vertical section of a portion of a boiler and feed valve, float, &c. *a*, Is the valve-chest, with its inlet or receiving branch, *b*, and outlet or discharging branch, *c; d d*, are two conical valves fast on the spindle of the float, *e*, which is a hollow copper ball. The seats of these valves are set in opposite directions, the upper one being for the overflow, and the lower one for feeding. As the valves are drawn, the boiler is supposed to be in the act of receiving its feed, through the lower valve, the actual level of the water being at *f*. The proper working level is represented by the sharp line above; when the ball-float arrives at this point, the lower valve will be closed, and the upper one opened simultaneously, so as to permit the feed-water to pass away. As the pressure of the water is equal on each valve, that of the steam only requires to be counterbalanced, which is done by weights on the upper end of the spindle. I have represented the valve-seats as bound down by strips coming from the valve-chest cover, the valves being joined together by a cutter driven in by the branch *b*. Where continual forcing is required, the weight of the valve may be applied as shown, but if a free discharge is permitted (the pressure being removed), a loaded lever may be substituted, and a little packing held down by the weight of a small ball, may prevent the escape of the water.

Fluctuation may be urged as an objection to this contrivance, but practice shows that if properly conducted, neither gorging or draining of the boiler can ever take place, the valve's motion being sudden, as it need not open more than ¼th of an inch. In the event of the float failing to work properly, the apparatus may be adapted for hand motion, by attaching a small crank and rod to the loaded lever.

ALEX. SUTHERLAND.

Dock Yard, Liverpool.

NIELLO-METALLIC ENGRAVING.

Ornamental art is by no means sluggish in its movements; it expands its arms in the most unheard-of directions; and, despite the allegations of the world of grumblers, it becomes naturalized amidst the every-day scenes and processes of domestic life, where once its shadow never fell. "Art-manufactures," it is true, are yet few in number and meagre in quality; we have yet to learn and accustom ourselves to the severity and classical purity of true greatness in art, as applicable to the ordinary details of home-spun materialism; but our pupilage is tolerably advanced, and our position as dabblers in the pure ocean of beauty is gradually improving. Germany has just added another promising branch to the flourishing parent stem, which gives fair promise of a luxuriant growth. We refer to the new method of producing ornament on metal surfaces, by what is termed the Niello-metallic manner. This invention, which is applicable to the production of ornament on a vast number of objects, is as follows:—The surface to be ornamented is first covered with an etching ground, as is ordinarily done in copperplate engraving; the design is then drawn with a needle point, and etched with an acid solution. The etching ground is then removed very carefully by a proper dissolving fluid, as oil of turpentine, or ether, and the object being washed perfectly clean, is submitted for a moment to the action of a weak acid solution. The next part of the operation consists in the depositing of the article in a galvano-plastic apparatus, until its surface is galvano-plastically covered; the etched lines being filled up with the metallic deposit. When this deposit is so thick as to reach as high or higher than the plain surface of the metal ground under process of ornamentation, it is removed, and the layer which has been deposited by the operation is ground or planed off to the natural level of the object, leaving the etched lines of the design full. A steel plate, with a galvano-plastic deposit of gold, gives a niello-gold ornament according to the etched design, and in like manner copper, or german-silver, may be treated. The process admits of the finest lines being etched, and inlaid close by broad planes in the galvano-plastic way, and with any number of different coloured metals. If it is intended to produce a design in various coloured metals, this may be readily accomplished by executing the etched design for each metal separately, the object being submitted in turn to the different galvano-plastic troughs of the ornamenting metals. In addition to this, if the etching is executed in broad lines, a variety of coloured ornaments may be produced by one etching; as, after the planing operation, the last deposit would appear as a single line in the middle, and the profiles of the first would represent fine borders. The invention possesses the grand merit of extreme flexibility, as its details may be modified so as to produce an immense variety of ornamental work. For such articles as watch-cases, gun-barrels, swords, metal boxes, and the generality of goldsmiths' wares, the facility and beauty of its applications are obvious.

CURIOSITIES OF THE APPLICATIONS OF SAND.

Of the multitudinous constituents of this nether sphere, silica, or the earth of flints, insignificant as it appears to the general observer, is perhaps the most active in its services in behalf of mankind. A sand heap is seldom looked upon in this light, for we are not wont to give it credit for higher offices than the formation of mortar, or its more familiar application to the housewife's floor. It forms by far the greater portion of the different rocks to be found in the structure of the earth: granite, which is supposed to be the only substance existing beneath the mere shell or crust investigated by geologists, may be considered as consisting of silica very slightly contaminated by foreign matters; quartz, and its allies, flints, agate, &c., are pure silica; so are the sandstones, mill-grit, and many other enormous beds of rocks. The limestone rocks abound with it, and of the clayey formations two-thirds at least are silica. The alluvial deposits and cultivated grounds from which we, and the animals we employ, derive our daily food, contain nearly three-fourths of their weight of sand.

Throughout the whole range of inorganic creation, this substance is universally found, and is manifold the most abundant of the earths. Were it not for the aid it affords, grain would not ripen on its stalk. Straw possesses a cuticle or skin abounding in sand, which is not taken up by the plant until the ear is formed, for then only does the stem require assistance to support the increasing weight of the grain. As the latter swells, the stem is gradually stiffened by the assimilated sand, building around the bottom column of the straw a tubular wall of flint, which keeps the ear erect, and directly exposed to the influence of the sun.

The busy workshop of nature abounds with admirable examples of the fitness of sand for an infinite variety of purposes, but our present intent is to point out a few of the applications of this material in the arts—man's ingenuity employed on the property of nature.

As an instance, we may mention that great agent in the cause of civilization—glass. Glass cannot be made without sand, which must be always present to the extent of from two-thirds to five-sixths of the bulk of the whole. To sand, then, we owe a weightier debt than to the whole of the remaining substances, as soda, potash, lead, boracic acid, lime, barytes, &c., used in combination with it. We can hardly form a conception of the accumulation of miseries which would be forced upon us by the annihilation of glass. How cheerless then our comfortable firesides; and what narrow apologies for windows should we have! No choice but the dismal alternative of shutting out sun and light, or being frozen or drenched at the caprice of the seasons. Like water, and other every-day valuables, we are apt to consider lightly the advantages of the "invisible stone;" and a course of drenching, freezing, and blowing, would perhaps alone bring us to a full appreciation of it. In the absence of glass, how greatly would the functions of that hand-maid of knowledge, the printing press, be disabled! And even this giant slave owes its existence to sand, for of what other material could we form the moulds for holding the molten metal employed in its construction?

The smith tells us he employs it for effecting the junction of his pieces of malleable iron; without its presence, his attempts to unite the softened surfaces would be in vain. The smelter again informs us that he must have sand to reduce his ores to the state of refinement of pure metals. All ores contain more or less a quantity of earthy particles, which must be removed in order to render the metal applicable to its infinite variety of uses, and to this end the impurities are formed into a glass; glass and metal mix together only after the fashion of oil and water, the heavier mass always subsiding. The oxides of the metals do, however, dissolve, and become intimately mixed with glass; and, in some instances, the oxidizing energy of the metal, and its consequent tendency to unite with glass, is sufficiently vigorous to decompose substances which, under other circumstances, entirely resist decomposition: and in such cases, glass so formed protects the metal it contains, from reduction in the furnace, reduction being the taking away the oxygen from a metallic oxide; thus bringing the oxide to its metallic base, as oxide or rust is reduced to metallic iron by smelting. An ore of iron frequently consists of oxide of iron, alumina (the earth of clay), and sand, in such proportions, that, if melted alone, the result would be the formation of a glass containing the oxide of iron in such a state as would defy all the art of the smelter to reduce; for if metallic iron is heated with a mixture of alumina and sand, some of the materials are decomposed, in order to oxidize so much of the iron as is necessary to form a glass with the alumina and silica; whilst the remaining portion of the iron becomes alloyed with silicon and aluminum, the metallic bases of silica and alumina. If lime or barytes is added to the ore, a perfect glass is formed of the sand, alumina, lime, or barytes, without the aid of oxide of iron, which, being left in a state of submission to the reducing power of the fuel of the smelter, becomes metallic, gradually subsides, and is drawn off at pleasure. The success of the operation depends upon the formation of a suitable glass; and so essential is the presence of sand, that if the ore does not naturally contain it, the smelter is compelled to supply it artificially, by adding a siliceous limestone.

Still more important is the part played by glass in copper-smelting. Here a glass must be formed to dissolve the iron, which is always present in copper ore, leaving the pure copper. This is generally accomplished in practice, by the mixture of two ores, (frequently the productions of the opposite sides of the globe,) one of which abounds in materials necessary to form glass with the earthy particles of the other. In such instances, the action of the glass is so energetic, that as it becomes saturated with oxide of iron, *all* the copper is precipitated perfectly metallic and pure. Manufacturers of coloured glass will doubtless recall to mind many circumstances analogous to this.

Smelting, then, mainly depends upon the formation of a glass to dissolve impurities, and set the metals free; hence, to *sand* we owe the possession of metals. Railroads, steam-boats, and the electric telegraph, rise up before us as we continue our survey of the results of the reduction of metals; and were we seeking for minute examples, we might instance the battery employed by the telegraph company. It is composed of plates of metal, separated by layers of sand saturated with an acidulated liquid; a small stream of fresh liquid pours upon the sand as the exhausted acid drains off below: thus a uniform electric current is maintained by these means for a longer time than by any other known method. This is one of thousands of elegant applications, but it is to general utilities that we wish to direct the attention of the reader. The house he dwells in, whether built of stone or brick, is indebted to sand for more than half its materials; to it the covering of the roof, whether thatch, tiles, or

slates, owes its existence; the wood employed in the structure grew by its nourishing assistance; the tools to fashion, the nails to hold, and the philosopher's rod to guard it from the attack of the lightning, are alike dependent upon it. The iron pot of the kitchen is cast in sand, and of all the various utensils of earthenware or glass, from the delicate porcelain vase or gorgeous mirror of the saloon, to the sturdy water jug or black bottle of the labourer's hut, none could be formed without it. We could add largely to our list of "curiosities;" but we have possibly already extended them sufficiently to show the practical importance of one of the simplest constituents of the material world. D.

MINE VENTILATION—IMPROVED PIT-VALVE.

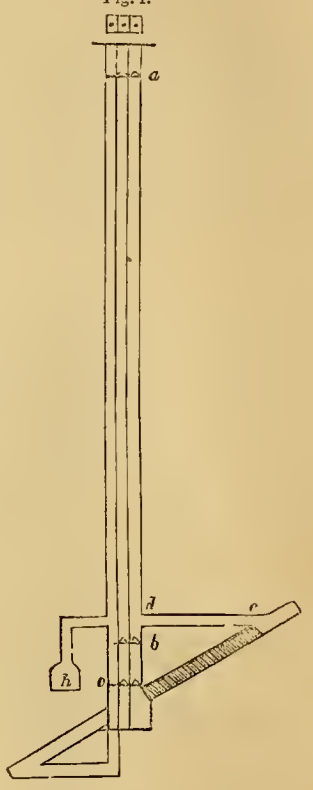
Explorers of coal mines have probably, like ourselves, witnessed the deplorable occupation of the "trapper." Placed behind a trap-door, in a long, dark passage, where the only sounds which reach him are the clank of the pick-axe, or the hollow rumbling of the blast, sits a child, generally of tender years, whose one only office is to open and shut a wicket as the miners pass and repass in their avocations. Divested of light—of companionship—of amusement—we may almost say of the means of employing his existence—he is the living picture of a breathing-machine—a door-shutting copy of humanity. Upon his punctuality and care, however, essentially depends the safety of the miner; without him, the natural enemies of the under-ground worker, choke and fire-damp, would speedily multiply beyond subjection, and yet his whole attention is directed to nothing more than the closing of a door.

All the workings in coal and other mines are so arranged, that a current of pure air may be constantly passing through them, in order to carry off the gases which continually issue beneath the miner's "pick." The present system of ventilation is such, that certain doors must be kept constantly shut, except for the short time that the waggons of coal, or the miners alone, require to pass through. It is for this end that the trapper is called into requisition, and even in these days of mechanical improvement, no substitute for his services has hitherto been found.

We lately had the pleasure of inspecting some valuable improvements connected with this and other improvable points in mining operations, the invention of Mr. George Simpson, mining engineer of this city, who has put them in operation in Bellsmoore shaft, in the lands of Roehsolloch, near Airdrie. Mr. Simpson's plans contemplate the removal of three objectionable features in mining—namely, the employment of trappers; the uncertain system of ventilation; and the danger resulting to life and property from the falling down the shaft of loose strata, or portions of the machinery.

Fig. 1 is a vertical section of the shaft, representing the self-acting valvular arrangement as applied to the working of one seam. By the ordinary system of trap-doors at the bottom of the shafts, as generally practised in Scotland, the air is conducted along one level, and after traversing the workings, returns by the other level. During the operations of the miners, these doors are repeatedly opened and shut, and frequent irregularities are thus caused in the ventilating current; moreover, the air, in circulating as here described, becomes exceedingly impure before it reaches the extremities of the workings, owing to the presence of smoke; and, in addition, a great quantity is lost in the interior of the waste.

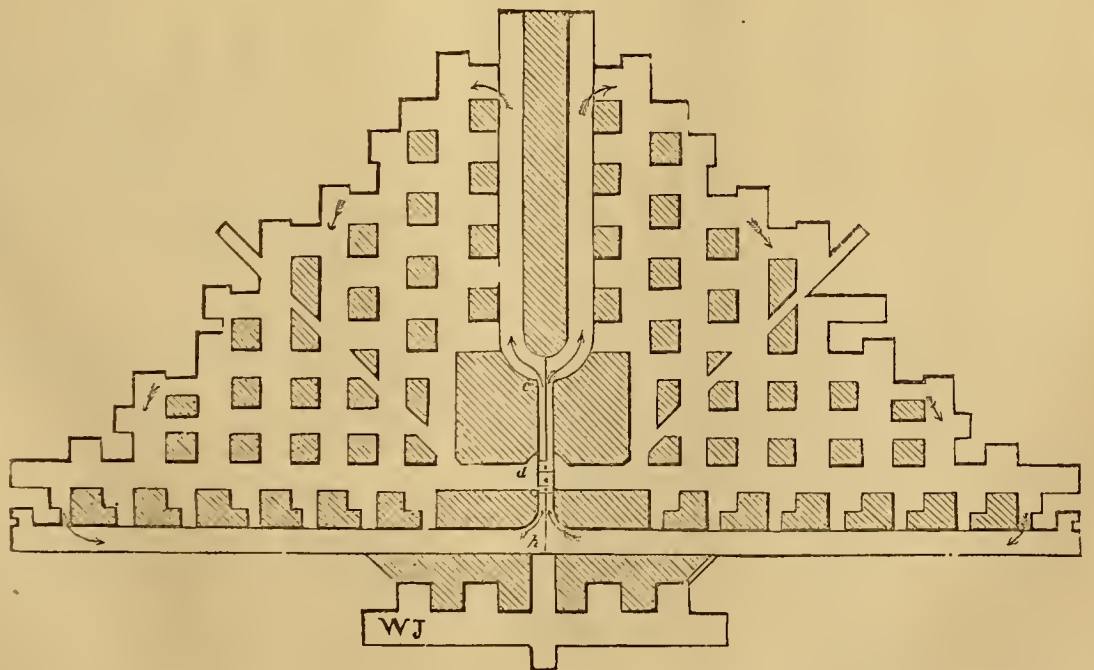
Fig. 1.



1-4th inch = 20 feet.

In the Bellsmoore shaft, this objectionable arrangement is got rid of, by the use of the air-tight valves, placed at from 3 to 6 fathoms from the bottom of the down-cast division, one being kept shut whilst the other may be open for the passage of the cage. Here no trappers are required, and the system does not involve additional power for the machinery. The screen-valves are seen at *a*, near the top of the shaft, their office being to prevent accidents in the way of falling down it; the air-tight valves are situated at *b c*, near the bottom, and are so arranged with respect to each other, that when one is open, the other is closed, so that a steady current of air is preserved throughout the workings. Immediately above the upper air-tight valve, a cross-mine is formed between the points, *d e*, communicating with the workings.

Fig. 2.



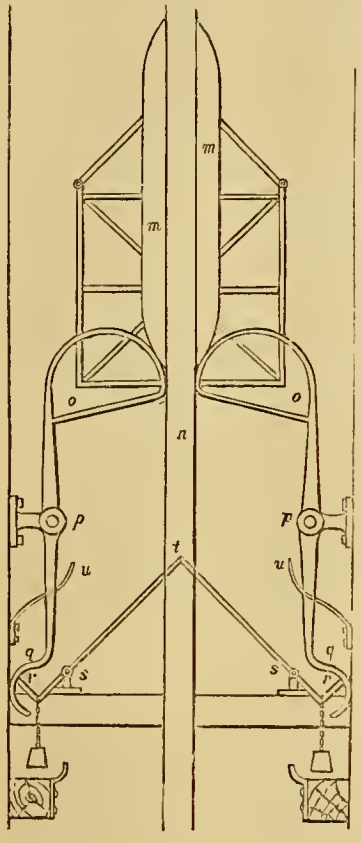
1-4th inch = 20 feet.

Fig. 2 is a plan of a mine on the pillar and room system, and in this case the air descends the up-cast division of the shaft, and is admitted by the mine, *d e*, in which is a division for conducting the air therefrom along each of the headings, where it communicates with the rise extremity of the workings, and after traversing therefrom to the level face, passes along the under level, and returns by the mine, *h*. The air may descend either side of the shaft, but should the low side he wet, it would be advisable to cause it to descend hy it.

The ends or offsets on the sides of the heading shown, and those along the rise-side of the air-levels, are all shut by buildings, except the one nearest the faces; by this the interior of the workings are constantly filled with fresh air, hut the current will obviously always take the most direct course, that is, along the working faces.

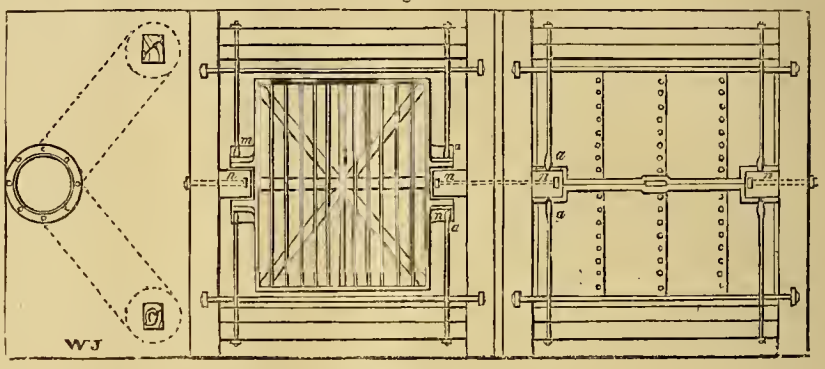
Fig. 3 is a sectional elevation of the cage used at the Bellsmoore shaft for raising coal, showing also the mode of action of the valves. The slides of the cage carry inclined projections, *m m*, shown embracing the guide, *n*; as the cage descends in the shaft, these inclined projections act upon the curved upper ends of the levers, *o o*, which oscillate in hearings fixed to the sides of the shaft. The lower extremities of these levers are curved, as seen at *q*, in order to act upon the rectangular ends of the leaves of the valve, which turn upon centres at *s*. As drawn in our figure, the valve is close shut, the point of junction of the two leaves being at *t*. When the projecting cams, *m m*, force out the upper ends of the levers, *o*, the curved ends, *q*, press upon the leaves of the valve at *r*, and raise them to a vertical position, so as to permit of the passage of the cage. Each leaf, as it rises, presses against the springs, *u*, the reaction

Fig. 3.



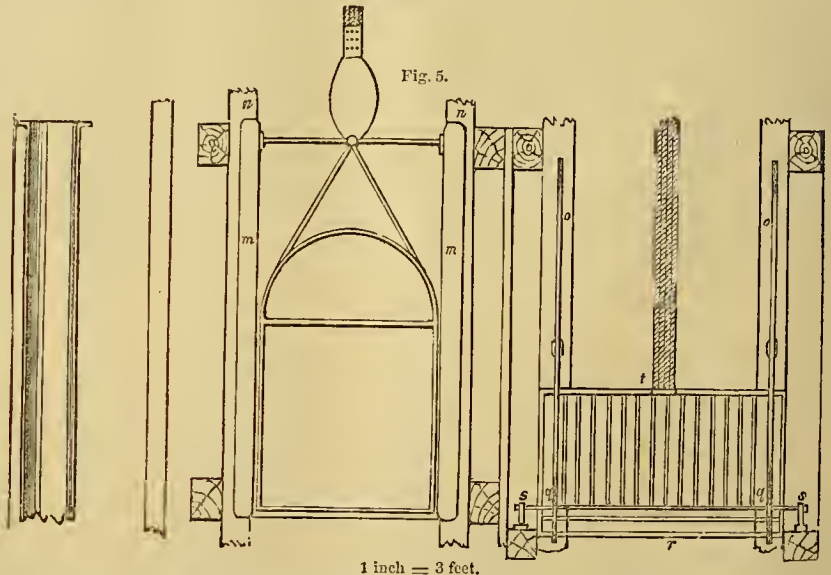
1 inch = 3 feet.

Fig. 4.



1 inch = 3 feet.

Fig. 5.



1 inch = 3 feet.

of which causes the leaves to close after the passage of the cage. The counter-weights at *r*, are simply to balance the overhanging weight of the leaves, and allow of their easy motion.

Fig. 4 is a plan of the cage and air-tight valve. The division to the right exhibits the air-tight valve as closed, an opening being left in the centre for the passage of the rope. In order to render the valve as completely air-tight as possible, without causing undue friction on the rope, a small anti-friction roller is placed on each side of it, and attached thereto is a flap of leather, which shuts up the aperture after the cage has passed above the valve. The opening of the valve at the rise of the cage is effected by the ball on the rope, placed immediately above the cage.

Fig. 5 is a side elevation of the cage and screen valve, as placed at the mouth of the shaft. At each valve, an excavation is made in the side of the shaft, for the reception of anything which may fall upon the valve, so as not to derange the action of the latter. By having a double cross mine driven level-course towards the rise, communicating with the seam and carried along the workings to the rise extremity, the waste situated on each side would receive equal supplies of fresh air, and the part at which hydrogen gas accumulates would he kept clear.

By the adoption of this simple arrangement, the Bellsmoore shaft is worked effectually without the employment of a single trapper, and Mr. Simpson may take credit to himself for doing away with an occupation, at once degrading and miserable.

RECENT PATENTS.

YULE'S IMPROVED RAILWAY CHAIR.

Loose and inefficient chairs are among the most frequent annoyances of the railway engineer, and they may be safely credited with a vast number of the casualties of the iron way. The shape of the chair, the mode of fixing, and the species of sleeper, are the chief points affecting the production of this evil, which arises on all lines, more or less, to a vast extent. The earliest lines of railway were all laid on stone blocks,

holes being drilled in the stone, for the reception of wooden trenails, which again received the iron holding-down spikes. This system is open to many objections, as the want of elasticity in the sleeper, the absence of any connection between the two lines, as a preservative of their parallelism, and the looseness of the chairs resulting from the oxidation of the metal spikes. The two first of these draw-backs have been remedied by the adoption of wooden sleepers, but the metal spike is still in vogue. The presence of moisture between the surfaces of the spikes and chairs soon causes oxidation, and the vibration produced by passing carriages, shaking off the loose film of oxide, enlarges the holes in the chair, and at the same time diminishes the diameter of the spike; thus looseness inevitably ensues.

We are indebted to Mr. Cubitt for the introduction of compressed wooden trenails, which have wrought a considerable change in the economics of railway up-holding wherever they have been introduced. Under this gentleman's directions, Messrs. Ransome and May of Ipswich, commenced a series of experiments on chair fastenings, which resulted in the discarding of the iron spikes, in favour of wooden ones, compressed

Fig. 1.

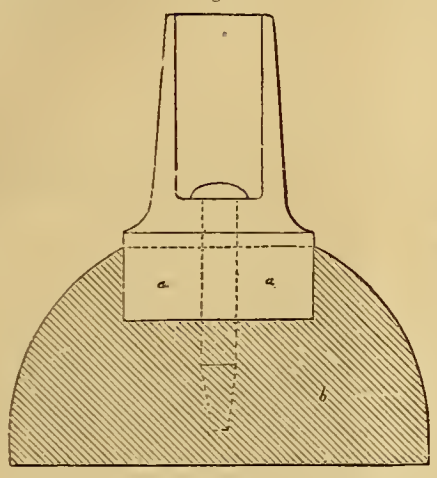
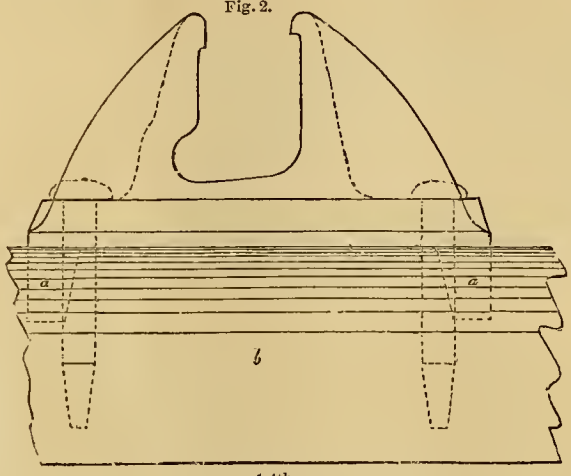


Fig. 2.



1-4th.

by forcing into a conical metal mould. Each trenail, after being introduced into the mould, is subjected to a considerable heat for a short time, in order to produce a permanent compression. The trenails thus prepared are diminished about 37 per cent. in bulk from their original size; and when affixed in the chairs, the subsequent swelling, from the reception of external moisture, gives them a firm hold in their sockets. Still, no provision was made for the security of the chair, further than the mere driving in of the spikes, and looseness is yet severely felt. To remedy this, Mr. Yule, of the firm of Yule & Wilkie of Glasgow, has introduced an additional means of attachment, which our engravings will explain. Fig. 1 is an end view of a chair as used on the North British Railway, with Mr Yule's improvement attached, and Fig. 2 is a side elevation of the same. In place of casting the sole of the chair perfectly plain, as is ordinarily done, the patentee forms, by casting or otherwise, projections, *a a*, one at each end of the sole. These projections are intended to be sunk into suitable recesses cut in the surface of the sleeper, *b*. The vertical section of the ribs or projections, may be either parallel or slightly tapered, but they must be well fitted to their recesses in the sleepers. The advantage of this improvement is, that from the large surface of metal in contact with the material of the sleeper, the strain arising from the concussions of the engine and carriages passing over the rails, will be sustained by the ribs, and the holding-down spikes will not suffer from this cause.

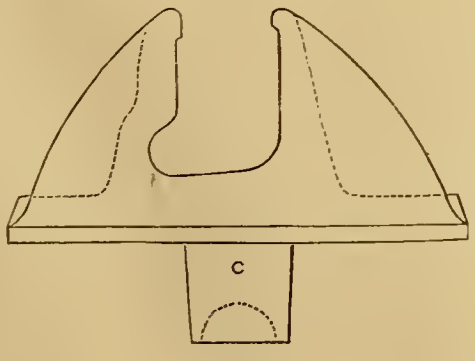
The ribs, *a a*, being cast as strong as the sole of the chair, it is evident that they will not give way until the chair itself is subjected to a strain it is incapable of bearing. The chances of splitting of the sleeper are also considerably diminished by this addition, as any lateral pressure will not act upon the spike, to cause a tearing or reuding of the fibres of the wooden sleepers.

Fig. 3 is a side elevation of a chair, fitted with one central projection only, as at *c*. This is of considerable strength, and the patentee proposes to dispense entirely with the holding-down spikes in chairs so fitted.

The patentee's claim is the forming of projections on the lower surfaces or soles of chairs used on railways, either by casting the same in one piece with the chair, or otherwise, as may be deemed advisable and judicious, and the forming of suitable recesses by cutting, or otherwise, in the sleeper or support of the chair, into which recesses the said projections are made to fit.

Patent for Scotland, dated 27th July, 1847. *Specification enrolled, 27th November. Drawn by* WILLIAM JOHNSON, *Patent Office, Glasgow.*

Fig. 3.



1-4th.

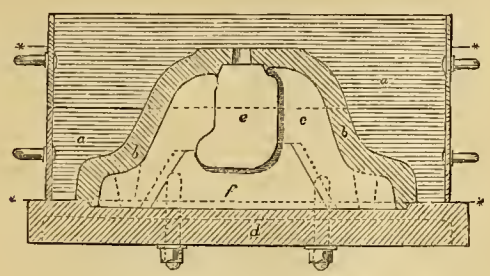
DARLING'S IMPROVEMENTS IN MOULDING RAILWAY CHAIRS.

Mr. W. Darling, ironmonger, of this city, has lately patented a variety of improvements connected with the production of railway chairs, with a view to the reduction of the cost of these necessary items in railway construction. The main feature of Mr. Darling's invention, is the adoption of metal moulds, in place of the ordinary sand moulds, as employed in casting chairs. This system has many advantages to recommend it, independent of the direct saving of time and labour attending its adoption. The greatest of these is the accuracy and uniformity of the chairs so cast. Every engineer knows how difficult a matter it is to manage a sand mould, so that any two articles cast in it may be exactly alike in finish and agreement with the pattern. This is of little consequence in the casting of the great bulk of articles coming within the iron-founder's province, as they are not dependent upon each other; but uniformity is the first requisite in the production of chairs, and a want of attention to this point is sufficient to derange the vital functions of a whole line of railway. Sand-moulding, in the hands of workmen of different abilities, even with the most accurate patterns, is found to admit of very great departures from exactitude, and even the same moulder finds it difficult to execute a series of castings exactly alike. A metallic mould, if advantageous in other respects, remedies this objection, and economises the time of the workman. Mr. Darling's ideas on this head will be easily understood from the annexed engravings, which are accurately drawn to a scale of 1-8th of the actual size.

Fig. 1 is a vertical section of the mould which the patentee employs in the casting of the matrix, or metallic mould, as it would appear after the pouring in of the metal to form the matrix; *a*, *a*, are two sand boxes, placed one above the other, as in ordinary moulding; *b*, *b*, is a section of

the newly-cast matrix, the interior surface of which corresponds to the exterior of the metallic pattern chair, *c*. Fig. 2 is a ground-plan of the bottom plate, *d*, upon which the sand boxes, *a a*, are placed; the latter, together with the matrix, being removed therefrom. In commencing to form a matrix by this mode, the workman places upon a plain mould-board (which mould-board has steadying pins corresponding to the under side of the lower sand box, *a*) so much of the pattern of the matrix, *b*, as is included between the dotted lines * * in fig. 1. This pattern is placed

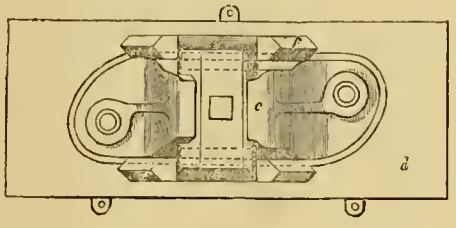
Fig. 1.



1-8th

in the exact position upon the mould-board which the mould will ultimately occupy when placed upon the plate, *d*. The lower box, *a*, is now adjusted upon the mould-board; and, being rammed up with sand, the upper box is similarly placed upon it. A bottom board is then placed upon the upper box, and the whole apparatus is reversed, and the pattern of the matrix is withdrawn. The pattern chair, *c*, which is employed in forming the interior surface of the matrix, is cast solid in the centre; a projection of the shape of the opening for the rail being cast on each side,

Fig. 2.

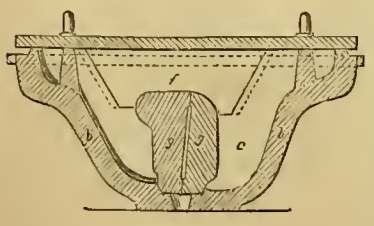


1-8th

as seen at *e e*, for the purpose of acting as cores for the openings to be made in the sides of the matrix. The pattern chair is attached to the plate, *d*, by screws, and the two sand boxes being adjusted over it, the whole is ready for casting the matrix, as represented at *b*, fig. 1.

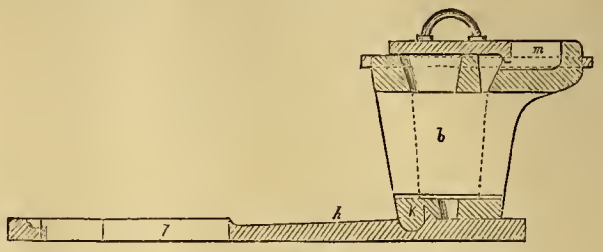
In fig. 3 we have shown a vertical section of the matrix, as fitted with its core keys and top plate, for casting a chair. The matrix is placed with its smaller side downwards, and the two wedge-shaped core keys, *g g*, are passed through the apertures formed by the projections, *e e;* a top plate is then placed over the open upper side of the matrix, when the apparatus is ready for casting a chair. Fig. 4 is a transverse vertical section of the matrix, placed upon what the patentee terms a turn-over plate, *h*, being hinged, as it were, thereto, by a knuckle at *k*. The use of this plan is, to assist in the removing of the chair from its mould after casting. It is simply a broad cast-iron plate, having formed in it a large aperture, *l*. When the chair is ready for removal, the matrix is turned over on its side by the knuckle *k*, and another turn upon the plate brings the sole of the chair immediately over the opening *l*, which, being just large enough to admit the chair alone, the latter, along with the core keys, is driven out, leaving the matrix on the plate. In order to permit of the exit of the chair and keys in this summary manner, the sides of the matrix are formed with loose adjustable pieces, as seen at *f f*. Counterparts of these side pieces are formed on the pattern chair, as seen in the plan, fig. 2, which produce openings in the matrix of the size required. The side pieces being cast separately, are afterwards fitted in their position by an angular joint. This mode also admits of the casting of the pouring-gate, *m*, separately, this being attached to one of the side pieces.

Fig. 3.



1-8th

Fig. 4.



1-8th

The facility of casting, which this process provides, is very considerable; and if the difficulties occasioned by the expansion of the matrices from the heat of the melted iron can be overcome, it will be only fair to surmise that it will be largely adopted.

As a further means of facilitating the casting of chairs, the inventor proposes to employ a circular ring, or table, movable in a circular direction, upon pulleys, carried by a set of standards attached to the floor of the moulding-shop. The moulds, with their turn-over plates, are arranged upon this ring; and as each mould is ready for receiving the metal, the ring is moved round until the mould to be filled arrives beneath a stationary metal ladle, which is suspended from above.

To improve the strength of the chairs, he proposes to remove them as early as possible from their moulds, and deposit them in annealing kilns or furnaces, or in a sand bath. The last head of the invention relates to the casting of chairs of metal taken directly from the smelting furnace. To accomplish this, a sufficient space is formed beneath the tap-hole of the furnace, in such a position as to allow of the removal of the metal by a ladle, in place of running it out through a sand gate as usual. In following out this plan, the workman commences to remove the metal as soon as it collects in the bottom of the furnace in sufficient quantity to fill the ladles without an admixture of slag.

The claims are,—First, the casting of railway chairs in metallic matrices or moulds. Second, the use of two or more wedge-shaped pieces of metal, for the purpose of forming the interior surfaces of chairs, whether such chairs are cast in metallic or other moulds. Third, the mode of applying the melted metal to moulds for casting railway chairs. Fourth, the annealing of railway chairs. Fifth, the use of melted metal taken directly from the smelting furnace, in casting railway chairs.

Patent sealed, June 10*th*, 1847. *Specification enrolled, December* 10*th*, 1847. *Drawn by* William Johnson, *Patent Office, Glasgow.*

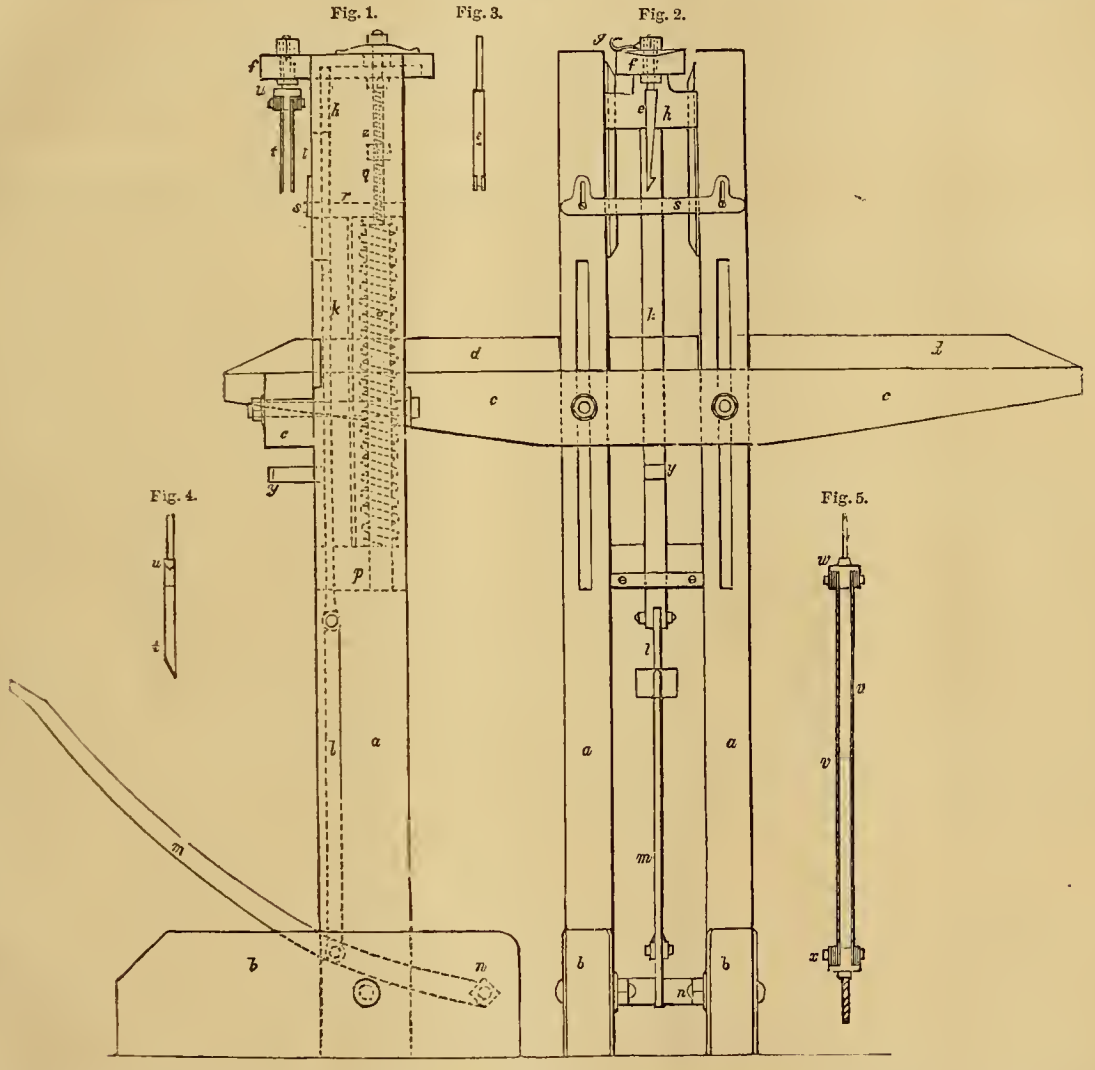
REGISTERED DESIGNS.

MORTICE AND TENON-CUTTING MACHINE.

Registered for John Mortimer, *Aberdeen.*

This machine possesses some highly ingenious and valuable features, constituting it one of the most necessary of the wood-worker's tools. Our engravings, which were made from a full-sized working machine, are in complete detail, and represent the inventor's improved plans of producing tenons. Fig. 1 is a side elevation of the machine, with its double-cutting chisel for tenons attached. Fig. 2 is a front view corresponding, showing the cutter employed in mortice-cutting. The frame consists of two vertical side-pieces of timber, *a a*, bolted to two bottom-supporting pieces, *b b; c c*, is the cross-bar for carrying the work. It is adjustable at different heights, by means of bolts passing through it, and through the vertical slots, *m*, in the pillars, *a a*, and is provided with a face-piece, *d d*, for the purpose of retaining the work square up in its proper position for being cut. The mortice-cutting tool or chisel, *e*, is fitted to a loose collar in the circular end of the cast-iron arm or tool-holder, *f*. This collar projects through the arm, and has attached to its upper end a fixed nut, carrying a spring-adjusting-lever, *g*, for the purpose of setting the cutter round to cut in opposite directions. The arm, *f*, is attached by a nut to the bent top of the sliding cross-head, *h*, which slides on guides on the inner edges of the pillars, *a a*. This cross-head is in one piece

with the connecting-bar, *k*, which is jointed by the liuk, *l*, to the treadle lever, *m*. The treadle is fast on a short cross-shaft, *n*, working in bearings in the foot pieces, *b b*. A spiral spring, *o*, is placed in a case between the two main frames, and is supported by a fixed cross-bar at *p*. This spring serves to raise the treadle and working apparatus after each stroke of the foot, and is connected to the cross-slide of the tool by the spindle, *q*, which is bolted to the arm, *f*, by the same nut which attaches the latter to the connecting-bar, *k*. The spindle, *q*, passing downwards through a fixed guide at *r*, is fitted with a nnt immediately below, acting as a collar for receiving the pressure of the spring, *o*, which is guided and supported by a wooden centre-piece fast to the spindle, and working through the cross-bar, *p*. A plate, *s*, is attached to the front of the pillars, for the purpose of preventing the rising of the work after each cut. In order to cut square down at each end of a mortice, the cutter, *e*, is capable of being set in opposite directions by means of the spring lever, *g*, which fits into notches cut on opposite sides of the circular end of the tool-holder, *f*, the frout upper surface of which is sloped away, so as to allow the catch of the lever to bear upon it only when approaching the two holding notches. Fig. 3 is a front view of the cutter, *e*, employed in morticing: it will be observed that its cutting edge is divided into two, thus facilitating its aetion upon the wood. In the side view, fig. 1, the improved tool for tenoning is represented as adjusted for action. It is composed of two narrow chisels, *t t*, adjustable at various distances apart, upon a T holder, *u*, by means of a series of thin slips of metal. As arranged in our figure,



the cntter is suited for prodncing a tenon to fit the mortice of the tool, *e*, each cutter removing the wood from the two sides, and leaving the tenon-piece in the centre, which latter is equal in width to the cutter, *e*. Fig. 4 is a side view of the tenon-cutter, showing the steadying notch in the adjusting slips. Fig. 5 is another arrangement for tenoning with saws; *v v*, arc two saws disposed npon the T pieces, *w* and *x*, similarly to the cutters, *t t*, in the last figure. The cylindrical portion of the piece, *w*, enters the tool-holder, *f*, while the contrary extremity passes through a slotted arm, *y*, upon the connecting-bar, *k*, the saws working through a slot in the supporting beam, *c c*. The arm, or tool-holder, *f*, is adjustable by means of the nnt on the top of the spring-spindle, so that the cutters may be set to aay required distance from the facc of the machinc. A nut, *z*, is adjusted on the spring-spindle abovc the fixed guide, *r*, for the purpose of acting as a stop in cutting blind mortices and other work, where a certain depth of cut only is required. The parts registered as new, in shape and configuration, as applied to the cutting of mortices and tenons, are —the adjusting spring-lever, *g*, of the tool-holder; the spiral spring, *o*; the chisel tenon-cutter, *t t*; and the saw tenon-cutter, *w x*.

REVIEWS OF NEW BOOKS.

Observations on Limes, Calcareous Cements, Mortars, Stuccos, and Concrete, and on Puzzolanas, Natural and Artificial; together with Rules deduced from numerous Experiments for making an Artificial Water Cement, &c. By Major-General Sir C. W. Pasley, K.C.B. Second Edition, Part I. London: J. Weale, 1847: pp. 209: Woodcuts.

The first edition of this work appeared so far back as 1838, and it must be no small source of gratification to its gallant author, that his

production should, at this distant day, be in such deserved request. The idea of experiments upon hydraulic cements, the results of which are contained in the volume before us, arose from the fact of the Duke of Wellington having issued an order to the effect, that practical architecture should, in future, form a part of the course of instruction for the junior officers of the corps of Royal Engineers at Chatham; and since that period, as the work abundantly shows, the author, acting upon a discovery of Smeaton's, has energetically devoted his attention to the production of a hydraulic cement from a mixture of clay and lime. He says —"By this memorable discovery, Smeaton overset the prejudices of more than 2000 years, adopted by all former writers—from Vitruvius in ancient Rome, to Belidor in France, and Semple in this country—who agreed in maintaining, that the superiority of lime consisted in the hardness and whiteness of the stone; the former of which may, or may not, be accompanied by water-setting or powerfully-cementing properties; and the latter of which is absolutely incompatible with them." Following out this theory, the author has succeeded, after numberless failures, in producing the best artificial water cement yet known.

As an instance of what accident often does for us when direct attempts fail, we find that, after experimenting with chalk and brick-loam, from Darland, near Chatham, without success, the mere chance of the employment of blue clay from the Medway, as being nearer at hand, resulted in the production of an excellent cement.

The method of testing the different cements here treated of, is at once simple and correct. This was nothing more than the setting out of piers or rows of bricks on edge, horizontally from a wall, by means of the cement only as a support. In commencing these experimental piers, a small rectangular portion of the supporting wall, sufficient for receiving the first brick, was scraped clean, the mortar being removed from its joints to the depth of half an inch, the space being filled with pure or net cement, the first brick being attached to it by fresh cement applied before that in the joints had set. When a fresh brick was added, it was immersed for half a minute in a bucket of water, the face to which it was to be attached being also wetted; after which, the cement was added to both surfaces, first in a thin coat to the wall, or fixed brick, and then in a thicker layer to the new brick. After the setting of each brick, it was held up by hand for five or ten minutes, in order to allow of the setting of the cement. In this manner, one brick was applied daily, until the pier attained such a length as to break with its own overhanging weight. A mixture of four parts, by weight, of chalk, and five of blue clay, sustained the extraordinary number of 31 bricks, amounting to a length of six feet eleven and a half inches, and weighing 186 lbs. A composition of three parts chalk, and four of blue clay, supported twenty-eight bricks, weighing 171 lbs.

The work contains a great number of experiments, with almost every conceivable species of cement; and to these, as well as to the general subject-matter of the volume, we shall again refer from time to time, as opportunity serves. We may remark that, in every detail of experiments, either of the manufacture of the cement, or the method of testing it, the greatest exactitude has been pursued;—as a book for the library of the practical professional man, we cannot give it a higher character.

Plane and Spherical Trigonometry. By H. W. Jeans, F.R.A.S. R.N. College. Second Edition, Parts I. and II., pp. each 126. London: Longmans, 1847.

The student of the present day is in a position very different to that occupied by his predecessors. Year by year new paths to learning are struck out, and old ones smoothed; and although there may be no royal road to scholarship, yet the plebeian routes are being gradually improved. The most talented books are written by the most talented men for his especial benefit; and one of them is before us. The first part of this work consists entirely of rules and their applications, whilst the demonstrations are placed in a separate volume, in order, as the preface tells us, "that the student may be enabled to proceed with problems in surveying, navigation, and astronomy, as soon as he is acquainted with vulgar and decimal fractions, and has acquired a sufficient knowledge of algebra to work an easy equation." This is a good arrangement, as it draws a distinctive line between the theory and the practice of the subjects treated of. Every facility which the elegancies of science suggests is here applied; and we perceive the new table of *log. haversines* of Dr. Inman is pretty generally introduced, thus materially shortening calculations in navigation, and the principal applications of plane and spherical trigonometry. The problems in surveying are very complete; and we are persuaded that the work, as a whole, is not destined merely for initiatory purposes, but may deservedly find a resting-place amongst other referential books of the surveyor and engineer.

The Tradesman's Book of Ornamental Designs. Parts I. to IX. London: W. S. Orr & Co., Paternoster Row. Edinburgh: J. Menzies.

Although we make the best steam-engines and spinning-frames, and stand at the head of hard-working practicians, we have yet to be imbued with the spirit of Ornamental Design. Possibly, if we were worse engineers, we might be better designers; for the very characteristics of the former profession, have all along appeared to be at variance with those of the latter. We find artizans employed in some of the most difficult branches of art-manufacture—silver-chasers, engravers on wood, and others, who, so far from possessing a correct knowledge of the scientific details of their professions, are not even able to draw respectably. In the preface to the work before us, we find some apt remarks upon this point. The writer says—

"In every means that may be adopted to impart an accurate knowledge of ornamental design to the ordinary mechanic, too much care cannot be observed, both as regards the examples set before him, and the way in which the necessity is enforced of a strict adherence to the true principles of art; for in cases where a certain degree of excellence has been acquired independent of a correct rule, the workman is not disposed to retrace his steps by undoing what he considers already sufficient for his purpose; and in the case of others who are less advanced, the rules and patterns of the shop are preferred to the rules of art, because more easy of attainment, and more in accordance with their limited views on the subject. It is thus no uncommon thing to find, in workshops where decorative art is practised, examples daily occurring of a total disregard of every element which constitutes either purity of taste or correctness or oneness of design. We see the Gothic mixed at random with the Grecian—the Elizabethan, the French of the period of Louis XIV., and the Flemish, with the Roman, the Moorish, and the Egyptian; and all these constantly overlaid with a variety of ornament invented for the occasion, the main object, in most cases, being to hide the defects resulting from an entire want of knowledge of the principles which ought to regulate the choice and arrangement of the various materials, and to arrive only at showy effects, however incongruous and deficient in good taste. Nor is the workman altogether to blame for this, seeing how little has hitherto been done to draw his attention to the all-important but simple fact, that mere natural talent and manual skill are in themselves inadequate to bestow that chasteness of style, correctness of detail, and dexterity in combination, so absolutely necessary to insure success in ornamental design."

Our government schools of design, it is true, are now fast spreading abroad a taste for the application of high art to useful ends. Let us hope that the change may be effectual and lasting. As an excellent agent in the work of imitation of handicraftsmen in all the various branches of art applicable to his pursuits, we may safely mention the "Tradesman's Book of Ornamental Designs." In the nine parts under notice, we find thirty-six beautifully executed plates, the productions of the lithographic establishment of Mr. Leith of Edinburgh. They contain specimens of ornamental work, applicable to every variety of trade connected in the smallest degree with the arts of design.

The first part commences with two examples of iron-work, the second of which contains a series of four chaste designs for perforated railing. In the same number, we find an admirable copy of an etching by Guido, after Lucas Cambiaso. The subject is a study of angels, and it presents a rare example of grace and freedom of execution. From such a collection, it would be a matter of difficulty to particularize the variety of commendable plates; but we may remark upon a book-cover from the Alhambra; Roman lamps, and patera; and a series of Moorish and Flemish scroll designs, as the principal ones that arrested our attention. Of iron-work we also find some beautiful examples from the Alhambra, and others of the Elizabethan and Gothic periods. Perhaps the best design of this class is one of Gothic trellis-work, which, with a similar one from the Flemish, may be catalogued as eminently rich and graceful. With the second part commences "An Essay on Ornamental Design," by Mr. Ballantyne, whose reputation is pretty widely extended in connection with the manufacture of stained glass. In this production, the author proceeds "to inquire into the nature and peculiarities of the various modes of embellishments and styles of decoration, invented and practised by different nations." In following out this course, he has treated of the ornamental arts of the Egyptians, the Romans, and the ancient Indians and Americans, illustrating the peculiarities of each nation, and the part which they have borne in the school of the world. The text is copiously embellished with well-executed woodcuts, and serves a valuable purpose, as an assistant for the practical application of the examples contained in the plates.

We shall watch the progress of the work with some interest, as we are persuaded its value will be deeply felt.

AN ESSAY ON THE AIR-PUMP AND ATMOSPHERIC RAILWAY, &c. By William Turnbull. Woodcuts: pp. 96. London: John Williams & Co., 141 Strand. 1847.

As a mathematician of considerable research and perseverance, Mr. Turnbull has long been well known, and this production will not detract from his standing in the professional world. It appears from the preface, that its origin is owing to the appearance of Mr. Robert Stephenson's report on the atmospheric propulsion, addressed some time back by that gentleman, to the directors of the Chester and Holyhead Railway Company. It is with an examination of this report, indeed, in connection with the experimental line of the Kingstown and Dalkey Railway, that a considerable portion of its pages are occupied. The result at which the author arrives, shows the atmospheric system in a slightly better position than that assigned to it by Mr. Stephenson. With all this, a perusal of the book leaves us with the undivided opinion, that the author's pen might possibly have been employed on a better subject; at any rate, the touchstone of practice speaks plainly of the deficiencies of the system.

THE ENGINEER'S AND CONTRACTOR'S POCKET-BOOK, for the Years 1847-8. Second Edition. Woodcuts: pp. 398. London: J. Weale, 59 High Holborn.

Mr. Weale has here presented us with a considerably improved edition of his Pocket-Book, as issued in December last. Amongst the new matter, we find a great variety of excellent practical details, as the "Railway and Building Contractor's Prices," containing minute statements of costs of rails, chairs, sleepers, and bridges; May's method of setting out Railway Curves; and very a full compilation of examples of American Engineering practice. This latter portion we look upon as one of the most interesting features of the book, and many hints may be gathered from it. From "American Contrivances," by William Redfield of New York, we extract the following, on the mode of procuring the lines of ships:—

"To the introduction of models, we are indebted for many of the very valuable improvements in the American packet-ships. The owner, as well as the builder, is made conversant with the form of his ship; by the aid of the model, he can readily trace any defect in her form. By thus singling out the assumed lines of flotation, and arranging them in their proper order, we have not only a perfect similitude of the ship, but have an ornament for the counting-house of the owner. In every instance in the United States, where a ship is constructed, the owner has the identical model, from which his ship was built, nicely mounted, varnished, and polished, and hung up in his office, where he is enabled, at any time, to reason upon her lines by a mere glance, and, by constant inquiries of his captains, as to whether she enters the water well, or how she leaves the water, or how she bears her canvas, either "forward," "midship," or "aft," in proportion to her hull; so that, in the succeeding ship, he may be able to suggest to the builder the propriety of an alteration, if such be needed. It is by a proper co-operation between the owner, master, and builder, "restricted by no tonnage law," that so many valuable improvements have been attained. When the draught of a ship is once drawn, it cannot be altered without defacing it in some degree, apart from the vast amount of labour lost. Without the aid of the model, the most practised and experienced builder cannot swell out the ship in his mind's eye: but give him the model, and he will detect an error at a single glance, that the builder, in working from the draught, may scan the several plans in vain to find. All the calculations necessary for the construction of a ship of any size, upon scientific principles, can be made with much greater facility than the model, and with that precision unattainable from the draught. The displacement of a ship may be readily obtained from the model, and thus, by the aid of the hydrostatic balance, the ship's actual line of flotation may be marked with precision before launching, which cannot be performed with the same degree of accuracy from the draught. The rotundity of the model enables the builder to obtain a correct expansion plan, which he cannot obtain from the several plans on paper; in proof of which, reference should be made to the various works on naval architecture, in which the expansion plans are extended upon a straight base line—an error but too manifest to every one conversant with the art of ship-building. It is quite evident, that to expand a ship upon a plane is to adopt one plan that is equivalent to the *sheer, half-breadth, and body plans*, or to obtain one form of line equal to the mean of the several forms on the original plan: this cannot be done from the draught, inasmuch as the central point from which the lines would recede in all directions, consequent upon the orbicular form of the ship, cannot be found; and, lastly, the vast amount of labour saved by the adoption of the model, gives it a decided preference over the draught.

The models are made of wood in alternate layers of red cedar and white pine, generally on a scale of $\frac{1}{2}$ or $\frac{3}{8}$ of an inch, the thickness of each layer being the vertical distance between the respective water lines.

The builder cuts, and carves, and *whittles*, until he has brought the model to the shape and dimensions that accord with his *notion*. The model is then taken to pieces, and a half-breadth plan is laid down, each water line being marked out from its corresponding layer in the model; this is again put together, and the elevation also laid out, and by the application of the scale by which the model was made, the relative distance is found of each and every line from one point to another: the measurements thus found are recorded in a table-book.

It is not at all unusual for the model to be made, the lines laid down, and the moulds completed for a ship of 1000 tons, within eight days after the receipt of the order, which, under the old system, would take certainly four times that period.

These models are preserved, and by reference to them the successive improvements may be remarked at a glance; and thus, by little and little, by slight modifications in each succeeding model, as experience may suggest, the present high state of perfection has gradually been attained."

In the continuation of this article, eleven well-executed wood engravings of American marine boilers, together with their principal details, are given as the results of the practice of some of the most celebrated makers. Haswell's American Pocket-Book has also furnished some valuable matter on general engineering construction. Altogether, the work presents a very spirited appearance, and shows an evident desire, on the part of its worthy editor, to keep up with the onward progress of the times. We shall probably refer to its pages on future occasions, as there are many other details worthy of recommendation to the notice of the engineer.

A PROBLEM.

Suppose (P) pounds raised one foot per minute, represented the power required to roll a certain cylinder over a certain uniform inflexible road at a given rate. Also, suppose $(P+x)$ pounds raised one foot per minute, represented the power required to roll the said cylinder at the given rate, over a certain uniform substance placed equally throughout upon the said road, the said substance being crushed thereby. *Question.*—Would the value of x be less the greater the diameter of the cylinder or the greater the value of P, supposing that the road, substance, and rate of motion remained the same? *Question* 2.—Suppose two cylinders of equal length and weight, one composed of lead, and the other composed of some material of less specific gravity; then, would less power be required to perform the said work with the latter cylinder (because of being the greater in diameter) than with the former one? Mathematical proof required.—[*Note* 1. It is a well-established fact, that the greater the diameter of the wheels of a carriage, (the axles remaining the same,) the less the power required to drag that carriage over any obstacles that the wheels may come in contact with; and the purport of this Problem is to determine whether the same is not true (within certain limits) with respect to the power required to drag a carriage over any substance that would be crushed by the wheels thereof passing over that substance.—*Note* 2. If the Problem should be objected to in consequence of having to consider the friction that the said substance would occasion to the surface of the cylinder, while or after being crushed; such objection may be obviated by supposing that the cylinder rolled over movable inclined planes of equal inclination and dimensions, and composed of the same material as the road itself, (which suppose, for example, was iron,) and so contrived that their upper surfaces would become parallel to the horizon when a certain pressure was produced thereon, each so by the same pressure, (the inclined planes being supposed to be connected with such machinery as would cause them to resist any pressure less than a certain pressure on their upper surfaces without their original position being thereby altered, and also such, that when and after their position became altered, however little, by the cylinder moving upon them, they would have no tendency to resume their former position,) and cause jointly as smooth a surface while the cylinder was passing over them as the road itself. Then moving those inclined planes to their limit, may be supposed to represent the crushing of the said substance.—*Note* 3. If the given cylinder exceeded a certain weight, (that is, a certain weight whose value depended upon the power required to crush the substance,) it would roll horizontally over the substance; because the centre of the cylinder would not in that case become vertical over any portion of the substance, until after such portion of it had become completely crushed.]

JAMES WALTERS, Jun.

Guildhall Hotel, London,
March, 1848.

CORRESPONDENCE.

ON THE FORMATION OF COAL.

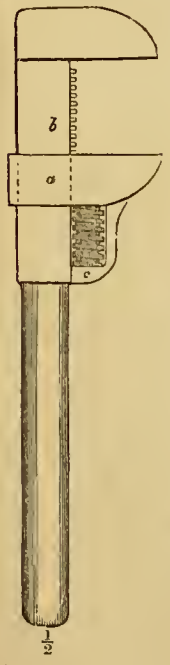
There are few matters connected with geology, which have attracted so much of the investigator's attention as the natural formation of coal. The various conflicting opinions as to this important subject will doubtless suffice, as reason enough, for my offering some observations, deduced from my own practical experience.

Geologists are generally unanimous as to the fundamental origin of coal—namely, that it arises from a deposition of arborescent and other vegetable organism, which have been drifted from the parent soil whereon they had grown, and subsequently attained a state of perfect quiescence at the bottom of seas and lakes, where they have been gradually converted into coal beds. How far this theory is to be trusted, may be judged from the following observed phenomena:—In the first place, I have invariably found that the arborescent deposits occur promiscuously, and are imbedded at all angles in the strata, yet I have never found any that was metamorphosed into coal. On the contrary, the matter has undergone a complete decomposition in the interior of the trees, leaving a mould which has been substituted, with a cast infiltrated from the material (generally of a sandstone or argillaceous composition) with which they are associated. The only portion of the tree which has become coal, is the outward coating, or bark.

Again, I have extracted a number of specimens, more especially of the genus *Lepidodendron*, from the very heart of one of our coal seams at present being excavated. The internal portions of these trees are composed entirely of sandstone, which forms the immediate superincumbent roof of the coal seam. Now, under these circumstances, I shall hardly be thought unreasonable in begging for a solution of these phenomena, from those parties who hold the opinion, that the interior woody or fibrous texture of trees has become coal. Why is it that the trees, whether found in the coal bed or intermediate strata, have not become coal? Certainly, if they have not had the same chemical action to influence their conversion into coal, in the general strata, they have at least had an opportunity in the heart of the coal seam.

THOMAS ROBERTSON.

Halbeath Colliery.



PARK'S IMPROVED SCREW-KEY.

I enclose you a sketch of an adjustable screw-key, which I have found very useful. In some keys I have seen the lever, where great strength is required, slotted through for the reception of the adjusting screw, thus weakening the instrument to a very great extent. You will observe that, in my plan, I get rid of this objection, by placing the adjusting screw outside of the lever. *a*, is the adjustable jaw of the key, mortised to slide on the square portion of the lever, *b*, and carrying a projecting piece, *c*, the extremity of which also slides upon the flat inner surface of the lever. A slot is cut in this projection, for the reception of the finger screw, *d*, which gears with a rack cut on the inner side of the lever. This key is simple, easily made, and not liable to get out of order: on this point I speak from experience, having had keys of this construction in use for two years.

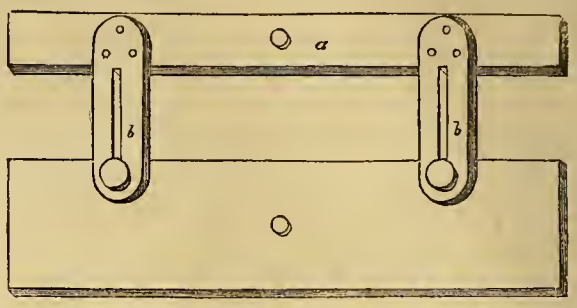
SAMUEL H. PARK.

Kingswood, Wotton-under-Edge, Gloucestershire.

SLIDING PARALLEL RULER.

As a slight modicum of information for the common collection, I forward you a sketch of a new parallel ruler, lately invented by a friend of mine. The motion of the parallel moving bar, *a*, being in right lines, the name of the sliding parallel ruler has been given to it, in contradistinction to the ordinary parallel ruler, the bar of which has a curvilinear motion. The brass connecting links, *b b*, are attached to the sliding-bar by three rivets, so as to be perfectly immovable. The links are each slotted down the middle for the reception of the fixed studs on the stationary bar. By this arrangement, it is obvious that the sliding-bar may be extended to any distance within the compass of the links, without moving out of a right line, and thus a much smaller ruler suffices than would be necessary if constructed with jointed links. As an example, I may state that, to draw the sketch annexed, it was necessary to employ a parallel ruler, 12 inches long; whereas, one of the improved construction, 6 inches long, would have been sufficient. I shall be glad to have your opinion upon its value.

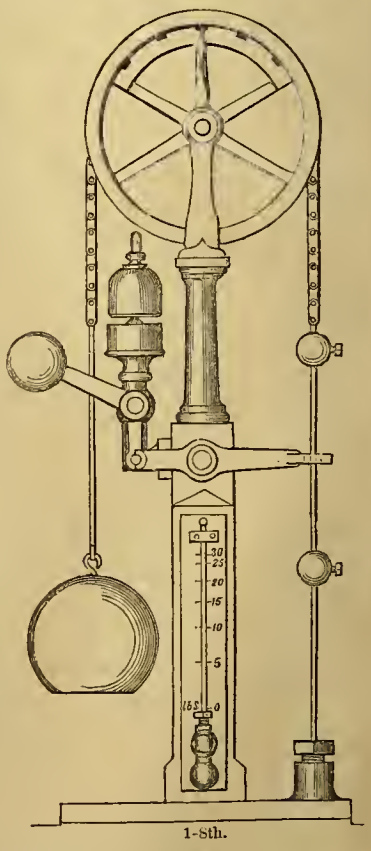
C. J.



[Parallel rulers, with rectilinear slides of various constructions, have been repeatedly proposed, but we are not aware of their having in any way rivalled the ordinary kind. Our correspondent's scheme is, however, simpler than any other which has come under our notice, and we have little doubt of its answering all requirements if accurately made. Probably, if the connecting links were lengthened a little, so as to embrace a second stud on the stationary bar, it might be an improvement.—ED.]

SELF-ACTING ALARM WHISTLE AND PRESSURE GAUGE FOR STEAM BOILERS.

The object of this apparatus is to call the attention of the fireman to any surplus or deficiency of water in the boiler; neglect, on this head, being one of the most frequent causes of explosion. The ordinary indicator of the height of water is simply a float, balanced by a weight passing over a fixed pulley, as shown in the design here given; but this arrangement serves only the same purpose as the glass guage, namely, to show the height of water when the fireman thinks proper to look at it. In order, then, to attract his attention to any irregularity in this respect, an alarm whistle is adapted to be worked by the float action. The rising or falling of the float will cause one of the two adjustable studs on the float spindle to come into contact with the actuating lever of the whistle, which will thus be detached from its hold upon the pin of the bell-crank lever on the whistle spindle, when the weight thereon falls and opens the whistle. In this arrangement, very little resistance is opposed to the movement of the float, as a slight touch of the studs will cause the weighted lever to detach itself from its catch.



The lower part of the supporting pillar is made to answer for carrying a mercurial pressure guage. This guage consists simply of a glass tube, hermetically sealed at the top, and made steam-tight at the bottom by a stuffing-box on the top of the mercury vessel. The lower open end of the tube is immersed in the mercury, upon the surface of which the steam from the boiler is admitted. As the steam pressure increases, the air within the tube becomes compressed accordingly, so that the mercury

rises therein, in obedience to the universal law of squares, thus indicating the amount of pressure with the greatest exactitude.

W. E. Carrett.

Leeds.

[An arrangement somewhat similar to Mr. Carrett's has been introduced to a considerable extent in this neighbourhood. The chain to which the balance-weight is attached, carries an index, pointing to a graduated scale on the supporting pillar; and, being continued downwards, it is attached to the valve lever of a whistle placed directly on the boiler. We consider ourcorrespondent's plan to have two advantages over this, namely, that it provides an index for the steam pressure, cleverly adapted to the balance-weight pillar, and, that the action of whistle is instantaneous.—Ed.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

In the records of the different bodies of scientific men, who have organized themselves for a purpose-like movement in the directions of discovery and practice, are to be fonnd some of the leading demonstrations of the actual improvements of the age. From the chance meeting of one or two clever energetic minds, to talk over general events, or exchange opinions of the latest theme of the world's wonderment, a knot of scientific explorers gradually accumulated. Here was the nucleus whence arose the strength of the societies of Great Britain, the history of some of which it would be a curious subject to trace, from the solitary speculative suggestions of the handful of originators, down to the present magnificent gatherings of the many illustrous men who adorn the scientific assemblies of the present day. The success of one institution has incited coutemporary observers to go and do likewise. The time-honoured Society of Arts has sent forth two eminently valuable bodies—the institutions of Civil and Mechanical Engineers. The value of the labours and researches of the first of these must be fully appreciated by all who are in any way connected with the profession, and the latter shows signs of activity worthy of an older establishment.

In our notices of the proceedings of these and other bodies, we shall at all times endcavour to keep in view such of the discussions and novelties as may be directly advantageous to the practical man. Aud in doing this, we shall deem it onr dnty, in addition to the furnishing of abstract reports, to seek out and illnstrate the details of any particular subjects which may demand a closer investigation than a mere report can give.

INSTITUTION OF CIVIL ENGINEERS.—March 14.

Joshua Field, Esq., President, in the Chair.

The paper read was "An account of the effect of the storm of the 6th December, 1847, on four sea walls of different forms, on the coast near Edinbnrgh, as illnstrating the principle of the construction of sea defences." By W. J. Macquorn Rankine, Assoc. Inst. C.E.

The principal example given was the sea wall of the Leith Branch of the Edinbnrgh and Dalkeith Railway, finished in the year 1837; built by the anthor from Mr. Walker's designs. Just after it was completed a violent storm occurred which injured almost every similar work within its range; but produced no ill effect npon that strncture. On the 6th December, 1847, a still more violent storm occnrred, which did great damage all around; but the railway wall still escaped without injury. The total length of the wall was abont 750 yards; its height was 13½ feet above the breach, at the highest point, diminishing to about 6 feet at the ends. The height of the top was 4 feet above equinoctial spring-tide level. Its least thickness was 5 feet, and its greatest 10 feet; the back was vertical, but the face had an inclination at the lower part of 5 inches in the foot. gradnally becoming curved, and rose npwards, until at the top it overhung slightly. The fonndation course was composed of large flats tones laid horizontally, 4 feet below the surface of the beach, npon a stratum of fine sand and gravel, firm when dry, but movable when wet. The face was of hammer-dressed ashlar, about 2 feet thick; the hack of rubble, 18 inches thick. The interior was filled with concrete. The coping was composed of stones, each weighing abont half a ton, connected by means of cast-iron dowels. The stone nsed was Craigleith sandstone; the face joints were laid in cement for a depth of 4 inches. The foundation was protected by a pitching of trap bonlders, laid on the natural level of the beach. They were partially disturbed by the storm referred to, and the anthor ascribed this to their weight being insufficient to resist the vertical oscillation of the waves.

The second example was a vertical sea wall near Trinity, the foundation of which, was protected by a dry stone bulwark, sloping at angles of from 30° to 4° The wall was nninjured by the storm, but the pitching was breached at several points.

The third example was another wall near Trinity, of a hyperbolic section. The lower part had a slope built dry np to a little below high-water mark. At this point there was a sharp curve, and the upper part was nearly vertieal, and laid in mortar. The waves extracted the stones of the curved portion, and the upper part, being undermined, was destroyed to a great extent.

The last example was the bulwark of the Granton Railway, the lower part of which sloped at about 20°; the upper portion was curved, and was covered by a heavy projecting string course and parapet. It was built dry, and the stones of the lower part weighed not less than a ton each. This bulwark suffered damage to a slight extent in its upper portion.

These examples were stated to confirm the following principles that the principal action of the waves in front of a sea wall was a vertical oscillation, produced by the combination of the direct and the reflected waves; that a sloping bulwark gave rise to a sloping oscillation, tending to overturn any portion which projected above the line of slope; that where the strength of a sea wall depended on the pressure of the superincumbent masonry, and the adhesion of mortar and cement, the position of greatest stability was vertical; and that where the strength depended on the weight of the individual stones, the position of greatest stability was a very flat slope.

In the discussion which ensued, instances were adduced of the duratiou of vertical walls under the attacks of heavy seas, and, on the other hand, of their destruction where flat slopes had effectually resisted the waves; and it was agreed that in this, as in all other cases of engineering, no empirical rules should be laid down, but that the skill of the engineer should be exerted to adopt such forms of construction as were best adapted to the locality and the circumstances.

The following papers were announced to be read at the meeting of March 21:—

No. 724. "Description of Wood the Bridge across the river Tees, at Lockburn," by H. T. Wright.

No. 770. "Description of Highton's Safety Railway Chair," by E. Highton, Assoc. Inst. C. E.

No. 785. "On Railway Junctions," by A. Beaulands.

THE SOCIETY OF ARTS.

At the second annual exhibition at the Society of Arts, in London, of "Select specimens of recent British manufactures," the nnmber of artieles exhibited is 666, and the number of exhibitors seventy. The specimens are divided into fifteen classes. Class 1. Modern marqueterie and woodwork. 2. Works in earthenware. 3. Works in coloured china. 4. Works in statuary porcelain. 5. Miscellaneous. 6. Works in cast-iron. 7. Modern British bronzes. 8. Works in silver. 9. Summerly's art-manufactures. 10. Chiefly, Minton's Parian. 11. Works in papier mâché. 12. Works in glass. 13. Wood-carving by machinery. 14. British marbles. 15. Bookbinding.—In point of design there is not any very marked improvement in the present over the former exhibition. In the beauty of the materials used, and the skill in using them, thero is however a very great advance. Mr. Summerly's art-mauufactures are among the best in the room, and make of course a great show. His statuette of "Dorothea," by Bell, is still, to our thiuking, the best and cheapest of his works, though his last manufacture. A bread plate, also designed by Bell, is extremely chaste and characteristic in design and execution. The great uovelty of the exhibition has been placed under the class "Miscellaneous." This is called (fantastically enough) "The *Repose* Arm-chair," a kind of Beaumont and Fletcher affair, got up by Mr. Thomas, the excellent sculptor of the statues at the House of Lords, aud by Mr. J. C. Horsley, one of the professors at the Government School of Design. The bas-relief represents a guardian angel and two side angels with musical instruments, watching over a mother and child and an old man sleeping. The lily, the passion-flower, and poppy are introduced as floral and appropriate ornaments. Thomson would hardly have admitted it into his "Castle of Indolence." "The Repose Arm-chair" is, however, only a design; and it is perhaps unfair to deal with it too severely. Among the works in statuary porcelain (Class 4) we were pleased to observe some of the pretty statuettes and busts of Mr. Copeland, of Lincoln's-inn-fields. We could wish that Mr. Copeland, who has done so much for the advancement of porcelain work, would undertake not to produce, but to reproduce. The material of his statuettes would do admirably well for the publication in small of Roubilliac's "Sir Isaac Newton," Bacon's "Dr. Johnson," Flaxman's "Sir Joshua Reynolds," and Chantrey's "James Watt"—capital chimney ornaments, which many would like to possess, not only as portrait statues, but as works of art. The "Sic Sedehat" figure of Lord Bacon, at St. Alban's,

39794

has lately been produced in this way by Mr. Jones, a modeller in Drury-lane, and has deservedly found a large sale among people who admire it for its many characteristic excellencies.—*Daily News.*—[The suggestion thrown out by the *Daily News* is excellent, and we hope it will be acted upon by some of our porcelain manufacturers. The list of subjects for statuettes might be much enlarged, and the works of foreign artists might be included. Thorwaldsen's *Byron* at Cambridge, Schadow's *Luther* at Wittenburg, Schaller's *Hofer* at Innsbruck, Schwanthaler's *Mozart* at Salzburg, the *Beethoven* at Bonn, Thorwaldsen's *Schiller* at Stuttgart, Schwanthaler's *Goethe* at Frankfort, and Geef's *Rubens* at Antwerp, would model admirably in porcelain, and the miniature reproductions would, we are quite sure, meet with ready sale amongst the admirers of genius. We will take this opportunity of saying, that we are much indebted to the *Daily News* for the reports and remarks on works in all departments of art which it from time to time contains.—*Ed. P. M. J.*]

ROYAL SCOTTISH SOCIETY OF ARTS.

At the request of the Council, an "Exposition on the strength of materials, particularly Cast Iron and Malleable Iron, and their application in the construction of Railway Bridges," (Part I.), was given, by Geo. Buchanan, Esq., F.R.S.E., President R.S.S.A.

Mr. Buchanan began by stating, that he did not profess to communicate anything new or original, but would be happy if he could only draw from the stores of information which had of late years been accumulating on this subject, under the hands of very eminent, scientific, and practical men, such leading facts and maxims as might prove a safe guide for our practice; and such truths, when they became known and established on the unerring grounds of experiment and calculation, could not, he thought, be too widely disseminated. The various strains might be all reduced to two kinds, according as the material is either distended or compressed by any force or pressure. From these two all others arise, and either consist or are compounded of them. The tensile strain is the simplest of all, depending neither on the peculiar form of the materials, nor even on the length, but only on a single element, namely, the Section of Fracture. This peculiarity of the tensile force was explained and illustrated. In regard to cast iron, the result of the extensive and interesting experiments by Messrs. Hodgkinson and Fairbairn was given, and it was found, from the mean of 16 different trials of English, Welsh, and Scotch iron, both hot and cold blast, that this material will sustain about 7½ tons per square inch before breaking, the weakest specimen being 6, and the strongest 9¾. The limit of fracture, however, can never be approached with safety, not even within a long distance, seeing that this material is liable to unseen imperfections, and, above all, to snap in a moment without distending itself, or giving any warning of danger. Malleable iron, again, is much superior in tensile strength, and, by its remarkable ductility, inspires confidence in a still higher degree; bears no less, at an average, by various experiments of Telford and Brown, than 27 tons—the weakest 24, and the strongest 29 tons; but, before the half of this load is applied, it begins to stretch, and continues stretching, up to the limit of fracture. It is, therefore, not only three times stronger than cast iron, but may be safely loaded with five times the breaking weight, or about 8 or 9 tons.

In regard to the strength of compression, this depends also, as long as the length is limited, on the same element—the section of fracture; but when a long rod or slender pillar is loaded or compressed, it is liable to bend, not for want of strength, but for want of stability, the least flexure turning it off its centre, and breaking it by lateral force, deranging entirely the simple law applicable to short lengths. In regard to cast iron, by far the most satisfactory experiments are those by Hodgkinson and Fairbairn. The mean result gives very nearly 50 tons on the square inch—the weakest 36½ tons, and the strongest 60 tons. It is thus six times stronger in compression than in distension, and hence it is peculiarly recommended for sustaining any superincumbent weight, as in the case of pillars and of bridges, provided the construction is such as to resolve the strain arising from the load into a longitudinal compression. This is often in our power by proper arrangements, chiefly giving a sufficient height and curvature to the arch; but in cases where, for the want of headroom, the arch is unduly flattened or resolved into a straight beam or girder, the danger is, that we bring the tensile force into play, and then the use of cast iron is objectionable, or at least requires extreme caution. No direct experiments have been made on malleable iron of short lengths; but from some facts brought out by Mr. Hodgkinson, its strength appears much inferior to cast iron, chiefly from ductility, whereby it gives way much sooner under a load. It will bear 27 tons, probably much more, without fracture; but with 12 tons it yields to the load, contracts longitudinally, and swells out laterally; and this is another very important fact for our guidance in the use of those different materials. In regard to stone, experiments have been generally made on specimens rather too minute. Like cast iron, the crushing strength is superior to the tensile, and hence its adaptation for buildings, particularly bridges. Craigleith stone will bear 2½ tons on the inch, or upwards of 400 tons on the square foot; Aberdeen granite, 600 tons. In regard to bricks, he had occasion to make experiments in relation to the great chimney of the Edinburgh Gas Works. It became matter of consideration whether the ordinary brick could withstand the pressure of so lofty a column. Trials were therefore made with a powerful hydrostatic press, not on small specimens, but on the actual brick. The ordinary stock brick was found to bear 140 tons on the square foot, and the common fire-brick 157 tons; but the brick of which the chimney is constructed, consisting of a mixture of fire-clay and ironstone, bore, a single brick on its bed, no less than 140 tons, equal to 400 tons on the square foot.

We shall probably recur to this paper in our next Number.

MONTHLY NOTES.

The Mines of Mexico.—It seems that the rich mines of Mexico, situate in the districts of Zacatecas, Guanajuato, and San Luis Potosi, are exciting the attention of the invading Americans, who hope to possess themselves at an easy rate of the sinews of war, and at the same time to hamstring their unfortunate neighbours. The mines are reported to be more productive now than at any former period. Taking the annual produce at 20,000,000 dollars, three per cent., the sum exacted by the Mexican government amounts to 60,000 dollars. This is an important item in a budget. The mine of Real del Monte pays the government 5,000 dollars monthly. The house of Mackintosh & Co. had the controlling of the mints in Mexico, Guanajuato, and Zacatecas, receiving the bars of silver from the mines at so much per mark (8 ounces). As this silver, in bars, contained 16 grains of pure gold to the mark, this house made a handsome profit by the arrangement, since no allowance was made for the purer metal. It is the custom in every country, when bar silver is coined in any quantity, to give the owners the value of the gold, after the expenses attendant on separating it are paid. The house above alluded to has represented to the government of the United States, that it would be better for the latter to prevent the exportation of silver in bars, unless at a high per centage. Many respectable Mexicans fancy that the great commercial house above spoken of, is playing a double game with Santa Anna and the Americans. They say that Santa Anna, before leaving the capital, made over to the head of the firm his haciendas at Encierro and Mango de Clava, with all the real estate he possessed in the republic.

Antimonial Paint.—Mr. J. A. Forrest, of Liverpool, has lately read a paper before the Polytechnic Society there, on a new mode of manufacturing white paint. He states that a superior body paint may be made from the white oxide of antimony, thus dispensing with the deleterious oxide of lead hitherto used. Antimonial paint has many advantages over that manufactured from lead. It does not lose its colour, and will spread over a much larger surface than an equal weight of white lead. Although antimony is now expensive, it is ascertained that, if a demand arose for it, it might be produced for £12 a ton, whereas lead costs £24 10s.

Waller's Caffetiere and Infusion Pot.—A peculiarly ingenious coffee-pot, which promises to be a valuable domestic convenience, has recently come under our notice. It consists of a cylindrical vessel, divided into equal parts by a horizontal partition slightly concave on its upper surface, somewhat like a dinner plate, and pierced with a hole at its centre. From the underside of this partition, and below a strainer placed over the central hole, a bent tube passes downwards into the lower division of the vessel, the extremity of the tube being fitted with a tap, the handle of which projects through the side of the pot. Ascending from within a short space from the bottom of the lower division, to nearly the top of the upper one, is a tube passing through the strainer and partition, to both of which it is attached; a small air-tight conical valve surmounts the top of this tube. When the apparatus is placed on the fire, the water in the lower division is forced, by the pressure of the steam, up the central tube, escaping at the top by the valve, and falling in a stream, at a gradually increasing temperature, upon the coffee which rests upon the strainer. So soon as the lower end of the central tube becomes uncovered, by the removal of the water to the upper division, steam alone arises, and the pot may be removed from the fire for use when required. When this removal takes place, the valve in the top of the central tube falls, and prevents the re-entrance of air into the lower chamber; the steam being permitted to condense, thus producing a partial vacuum in the lower division, the spout from which is closed up by an air-tight stopper; this vacuum then may be rendered available for the filtration of the coffee at any time, by opening the stopcock of the bent tube leading from the strainer.

Rapid Extension of Certain Trades.—In a late Parliamentary return, compiled by Mr. Saunders, the inspector of factories, we find how great has been the increase of certain branches of manufacture. During the last three years, the cotton trade has increased nearly 27 per cent., and the raw material has consequently risen from 4d. to 6d. per lb.; while twist, owing to the greater supply, sells for a fraction only more than when cotton was at its former rate. The woollen trade began to extend in 1836, and since that time Yorkshire has increased its manufacture 40 per cent., and Scotland presents a still higher ratio. As regards worsted, calculations give a result of 74 per cent. increase in the same time; the consumption of raw wool has therefore been immense. Flax has not increased to the same degree; but this branch shows a production of 25 per cent. more since 1839, in England; in Scotland, 22; and in Ireland, so much as 90 per cent.; and, as a consequence, in addition to bad crops, the raw material has gone up to £10 a ton, while yarn has fallen 6d. a bundle.

LAUNCH.—On Wednesday the 8th ult., a new iron steamer, the "Fair Trader," was launched from the building-yard of Messrs. Smith & Rodger, at Govan. She is intended to ply between Newhaven, Largo, and Kirkaldy, and is the property of Mr. Andrew Greig, of the Chain-pier, Newhaven. Her rough dimensions are—length, 150 feet; breadth of beam, 17 : 6; tonnage, 230; 80 horse-power.

CASE OF THE "CRICKET" STEAMER.—Previous to the late proceedings which have taken place in the sheriff's court, against the proprietors of this unfortunate boat, a considerable amount of misconception existed as to the really blamable party in the matter. We are glad to see that the juries in these cases have come to the conclusion, that when the safety-valves of the boilers are tied down, and an explosion ensues, the builder of the boat is hardly the right party to condemn. Had we not the details before us, the chances are that we should be astounded at the bare idea of laying the onus of such a casualty upon the constructor of the boat, who could not possibly have any connection with the working of the valves from day to day. If he made the boiler of a sufficient strength to stand the requisite pressure, the safety valves large enough, and the general arrangements proportioned to the due production of the necessary quantity of steam (and, from the evidence adduced, these points have been most fully attended to), we may well ask, wherein he failed in his duty to the public? The before-mentioned proceedings have, however, definitely settled the matter, and Mr. Joyce is now set right with the public, and exonerated from any share whatever in the negligence or inattention which is to be looked upon as the proximate cause of the fatality.

MESSRS. WILSON'S LOCOMOTIVE.—Messrs. E. B. Wilson & Co. of the Railway Foundry, Hunslet, Leeds, have lately completed a new locomotive engine for the Midland railways, on the Cambrian system. The arrangement consists of a segmental steam case, placed between the leading and central wheels, and within which case, an oscillating piston is fitted. The shaft of this piston carries a double lever, from the contrary ends of which a connecting-rod passes to an outside crank on the axles of the front and central wheels. By the adoption of this plan, the centre of gravity of the engine is considerably lowered, and the strain and vibratory motion of the piston is removed. As regards speed, the new engine on one occasion reached 80 miles per hour; and its powers of traction are set forth by the fact of its having taken 53 loaded waggons, weighing 430 tons. The Railway Foundry, 18 months ago, turned ont only 16 engines yearly; it now employs 1,000 hands, and turns ont 7 per month.

ENGLISH PATENTS.

Sealed from January 1st, 1848, to March 16th, 1848.

Edward Humphreys, Holland Street, Surrey, engineer,—"Certain improvements in steam-engines, and in engines or apparatus for raising, exhausting, and forcing liquids." January 4th.

William Froude, Darlington, Devon, civil engineer,—"Improvements in the valves used in closing the tubes of atmospheric railways."—5th.

Read Holliday, Huddersfield, manufacturing chemist,—"Improvements in lamps."—5th.

Charles De Bergue, Arthur Street West, City, engineer,—"Improvements in carriages used on railways."—5th.

Alexander Robertson Arrot, manager of the Union Place Glass Works, St. Helens, Lancaster,—"Improvements in manufacturing common salt."—5th.

Charles Lambert, Two-Mile Hill, St. George's, near Bristol, penmaker,—"Certain improvements in machinery for making nails."—5th.

Josiah George Jennings, Great Charlotte Street, Blackfriars Road, City,—"Improvements in cocks or taps for drawing off liquids and gases."—5th.

George Bell, Dublin, merchant,—"Certain improvements in the arrangement of wheels and axles for steam and other carriages, which facilitate travelling on railways and common roads, parts of which improvements are applicable to other machinery."—7th.

James Montgomery, Salisbury Street, Middlesex,—"Certain improvements in pianoforte and other similar finger-keyed instruments."—11th.

Alfred Augustus de Reginald Hely, No. 11, Cannon Row, Westminster, and Joseph Emmett Norton, St. Mary-le-Strand Place, Kent Road, Surrey, wine-merchant,—"Certain improvements in bottles or vessels for containing liquids, and in the mode of, and machinery or apparatus for, filling and stopping the same."—11th.

Gardner Stow, late of King Street, Cheapside, but now of New York, gentleman,—"Improvements in apparatus for propelling ships and other vessels."—11th.

Job Cutler, Spark Brook, Birmingham, civil engineer, and Charles Robinson, of the same place, gentleman,—"Certain improvements in welded iron-pipes or tubes, to be used as the flues of steam-boilers."—13th.

Robert Heath, Heathfield, Manchester, gentleman,—"Certain improvements in the method of applying and working friction-brakes to engines and carriages used upon railways."—13th.

Benjamin Mitchell, Huntingdonshire, farmer,—"Improvements in the manufacture of manure."—13th.

Sydney Edwards Morse, Ampton Place, Gray's Inn Road,—"Improvements in the manufacture of plates, or surfaces, for printing or embossing."—13th.

Robert Wilson, Master of Arts, Greenock,—"Improvements in certain kinds of rotatory engines worked by steam or other elastic fluids, part of which improvements are applicable to rotatory engines worked by water or by wind; also, an improvement in safety-valves for steam-boilers."—13th.

William Thorold, Norwich, engineer,—"Improvements in turn-tables."—13th.

George Gilmore, Lieutenant in the Royal Navy,—"Certain improvements in ventilating ships and other vessels."—17th.

Charles Crane, Stratford, Essex, manufacturing chemist, and James Thomas Jullion, of the same place, analytical chemist,—"Improvements in the manufacture of certain acids and salts, and a new apparatus applicable to the said improvements."—18th.

Samuel Cunliffe Lister, Esq., Manningham Hall, Bradford,—"Improvements in stopping railway trains and other carriages, and generally where a lifting power or pressure is required."—18th.

John Hickman, Birmingham,—"Improvements in the means of constructing and connecting parts of bedsteads, couches, and other articles of furniture, in which such improvements may be applicable; and also in the means of attaching knobs or handles to drawers, doors, and other parts of furniture."—18th.

William Newton, Chancery Lane, Middlesex, civil engineer,—"Improvements in the manufacture of sugar from the cane."—18th.

John Frederic Bateman, Manchester,—"Certain improvements in valves or plugs for the passage of water or other fluids."—18th.

Thomas Robert Sewell, Carrington, Basford, Nottingham, chemist,—"Improvements in preparing flour."—18th.

Joseph Clinton Robertson, Fleet Street, Middlesex, civil engineer,—"Certain improvements in the manufacture of textile fabrics, stuffs, and tissues, and of certain new products obtained by the aid of such improvements."—19th.

John Duncan, Brentwood, Essex, gentleman,—"Certain improvements in tanning of hides."—20th.

Henry Heywood, Blackburn, Lancashire,—"Certain improvements in looms for weaving."—22d.

William Hudson, Burnley, Lancashire, machine-maker, and John Drageon, Burnley, overlooker,—"Certain improvements in looms for weaving."—22d.

Henry Hornblower, late of Dalgleish Place, Commercial Road, Middlesex, but now of Devon's Lane, Bromley, engineer,—"Certain improvements in machinery for exerting motive power, and for raising and forcing fluids."—25th.

Thomas Topham, Ripley, Derbyshire, manufacturer,—"Improvements in the manufacture of time-tables."—25th.

George Fergusson Wilson, Belmont, Vauxhall, gentleman,—"Improvements in treating and manufacturing certain fatty or oily matters, and in the manufacture of candles and night-lights."—25th.

Henry Highton, Rugby, Master of Arts, and Edward Highton, Regent's Park, Middlesex,—"Improvements in electric telegraphs."—25th.

James Barr Mitchell, M.D., and Thomas Best Woolryche, chemist,—"Improvements in the manufacture of soda, and in treating products obtained in such manufacture."—25th.

The Right Honourable Thomas Earl of Dundonald, Vice-Admiral of the White Squadron of her Majesty's Fleet, Knight Grand Cross of the Most Honourable Order of the Bath,—"Improvements in marine steam-boilers, and apparatus connected therewith."—February 11th.

Horatio Black, Nottingham, lace-maker,—"Improvements in evaporation."—14th.

John Watson, merchant, and Edward Cart, gentleman,—"Improvements in the manufacture of gas."—14th.

James Timmins Chance, and Edward Chance, Birmingham,—"Improvements in furnaces, and in the manufacture of glass."—14th.

William Tottie, Crosby Square, merchant,—"Improvements in distilling."—14th.—Communication.

John Weston, Portland Town, Middlesex, machinist,—"Certain improvements in obtaining and applying motive power."—16th.

Joseph Barber Haxby, Dewsbury,—"Improvements in making communications between the guards, engineers, and other servants in charge of railway carriages, and also between the passengers and such servants, which improvements are applicable generally where speedy and certain communications are required."—16th.

Edward Massey, Middleton Square, Middlesex, watchmaker,—"Improvements in logs and sounding apparatus."—18th.

Edward Duncombe Lines, Chelsea, and Samuel Luiz Freemont, Love Lane, City, gentleman,—"Improvements in the manufacture of colours, oils, and varnishes, and in the manufacture of charcoal; and also in treating vegetable substances for, and in obtaining extractive matters therefrom."—18th.

William Irving, Trigon Road, Kennington, engineer,—"Improved apparatus for cutting or carving ornamental forms in wood, stone, and other materials."—23rd.

James Nasmyth and Holbrook Gaskell, engineers,—"Certain improvements in machinery or apparatus for forging, stamping, and cutting iron and other substances."—23rd.

Elizabeth Wallace, Laurel Lodge, Cheltenham, Gloucester, spinster,—"Certain improvements in facing, figuring, designating, decorating, planning, and otherwise fitting up houses and buildings, parts of which are applicable to articles of furniture."—28th.

John Craft Roberts, Holywell, Flintshire, surgeon,—"A simplified and improved mode of communicating intelligence, by means of electricity and magnetism, combined or not, with steam on railways, between the carriages on the line and the engine or tender, so that the guards and passengers may give notice to the engineer or engine-driver, for the prevention of accidents or casualties, or the mitigation of the evils thereof, and the protection of human life and property from loss or injury; and, also, of communicating signals by the same agency, describing the cause or causes of alarm, and a new mode of securing the passage of electricity for the above purposes, to be substituted or not for the side chains, and of communicating intelligence between distant places on the line."—28th.

William Palmer, Sutton Street, Clerkenwell,—"Improvements in melting fats, and in the manufacture of candles."—28th.

Charles Ritchie, Aberdeen, Scotland, engineer,—"Certain improvements in locomotive and other engines."—March 2d.

Francis Wishaw, Hampstead, Middlesex, civil engineer,—"A certain manufacture of pipes of earthenware, pottery, and glass, and of certain applications and arrangements thereof."—8th.

William Exall, Reading, Berkshire,—"Certain improvements in thrashing machines, and in steam-boilers, engines, and other apparatus for driving the same, which apparatus is applicable to driving other machinery, part of which improvements are a communication, and the remainder is his own invention."—8th.

James Loebhead, Milton, Gravesend, Kent, gentleman,—"Certain improvements in ventilation."—8th.

Theodorus Cornelius Segers, knight, Saint Gravenhage, Holland, but now of Leicester Square, Middlesex, physician,—"Improvements in the construction of railway carriages."—8th.

William Becket Johnson, Liverpool, engineer,—"Certain improvements which are applicable to locomotive, stationary, and marine steam-engines."—8th.

Warren de la Rue, Bunhill Row, Middlesex, manufacturer,—"Improvements in machinery used in the manufacture of cardboard and pasteboard."—(Being a communication.)—8th.

John Houston, Stepney, Middlesex, surgeon,—"Improvements in obtaining motive power by the aid of atmospheric air, and in obtaining combustion."—8th.

George Boyce, Fletland, Lincoln, miller,—"Improvements in machinery or apparatus for depositing, cleansing, and grinding corn and seed."—8th.

George Lloyd, Stepney, Middlesex, iron-founder,—"Certain improvements in furnaces and blowing machines, and improvements in engines and machinery for driving the same, which improvements are also applicable to other purposes where motive power is required."—8th.

Joseph Maudslay, of the firm of Maudslay, Sons, & Field, engineers,—"Certain improvements in obtaining and applying motive power, and in the machinery and engines employed therein."—8th.

John M'Conochie, Liverpool, and Louis James Claude, Bootle, Lancaster, civil engineers,—"Certain improvements in locomotive engines."—8th.

Alexander Alliott, Lenton Works, Nottingham, bleacher,—"Improvements in apparatus used in the working of steam-boilers; also, in apparatus used in cleaning flues."—8th.

John Henderson Porter, Blackheath, Kent,—"Improvements in iron girders, beams, trusses, and supports, and in rendering the floors of buildings fire-proof by the use of iron."—8th.

Henry Bashard, Hobaell, city of Oxford, goldsmith,—"Improvements in studs and buttons."—9th.

George Coode, Haydock Park, Lancashire,—"An improved method or methods of distributing over land, liquids and substances in a liquid or fluent state, and certain improved apparatus and machinery employed therein."—11th.

John Ashbury, Openshaw, near Manchester,—"Certain improvements in the construction and manufacture of wheels for use upon railways and common roads, and in the methods of preparing and constructing the tyres used thereon."—11th.

Alexander Alliott, Lenton Works, Nottingham, bleacher,—"Improvements in spring apparatus and in balances; also in breaks, and in the means of working breaks."—14th.

James Porritt, Edenfield, Lancashire,—"Certain improvements in carding-engines for carding wool and other fibrous substances."—14th.

Frederick William Michael Collins, and Alfred Reynolds, both of Charterhouse Square, Middlesex, engravers and printers,—"Improvements in the art of ornamenting china, earthenware, and glass."—14th.

John Hosmer, New Cross, Surrey, surveyor,—"Improvements in apparatus for supplying water, and for cleaning drains and sewers."—16th.

SCOTCH PATENTS.

Sealed from 1st *January*, 1848, *to* 18th *March*, 1848.

George Alex. Miller, Piccadilly, London,—"Improvements in lamps."—January 5th.

George Ambroise Michant, Epieds, France, now of 9 Gerrard Street, Soho, London,—"Improvements in the production and application of lead, and in the manufacture of coke."—10th.

Hector Sandeman, Tulloch Bleachfield, Perthshire,—"Improvements in the materials and processes employed in dressing, scouring, and bleaching certain textile fabrics, and the materials of which such fabrics are composed."—25th.

Robert Weare, Argyle Street, Birkenhead, watch and clock maker,—"Improvements in clocks and time-keepers."—25th.

William Watson Pattinson, Felling, Gatesbead, chemical manufacturer,—"Improvements in the manufacture of soda."—27th.

Stopford Thomas Jones, Stamford Street, London, lieutenant in her Majesty's service,—"Improvements in steam-engines, and in machinery for propelling vessels."—27th.

Richard Roberts, Manchester, machinist,—"Improvements in machinery for preparing and spinning cotton, and other fibrous substances."—28th.

William Baines, Norwich, inspector of railways,—"Improvements in the manufacture of parts of railways, and in bearings of machinery, and in apparatus used in constructing railways."—February 1st.

Thomas Lambert, New Cut, Blackfriars Road, London, brass-founder, and Charles William Rowley Richards, Charlotte Street, Blackfriars, engineer,—"Improvements in water-closets, and in cocks for drawing off liquids and gases."—1st.

William Thomas, 129 Cheapside, London,—"Improvements in stays;" which improvements are applicable to other useful purposes. (Communication.)—3d.

George Henry Bursill, Hornsey Road, London, engineer, and Joseph Radford, Maida Hill, London,—"Improvements in envelopes, wrappers, and covers, and in machinery and apparatus for the manufacture thereof."—3d.

George Fergusson Wilson, Belmont, Vauxhall, London,—"Improvements in treating and manufacturing certain fatty or oily matters, and in the manufacture of candles and night-lights."—3d.

Henry Bessemer, Baxter House, Old St. Pancras Road, London, engineer,—"Improvements in the manufacture of plates, sheets, or panes of glass."—3d.

John Harvey Saddler, Holbeck, Leeds, Scotch iron merchant,—"Improvements in constructing bridges, aqueducts, and similar structures."—4th.

Aime Boura, Rathbone Place, London, dyer and scourer,—"Improvements in extracting colouring matters."—7th.

John Frederick Bateman, Manchester, civil engineer, and Alfred Moore, of the same place, civil engineer,—"Improvements in valves or plugs for the passage of water or other fluids."—9th.

Thomas Hancock, Stoke, Newington, London,—"Improvements in fabrics, elasticated by gutta percha, or any of the varieties of caoutchouc."—11th.

Godfrey Anthony Ermen, Manchester, cotton-spinner,—"Improvements in machinery or apparatus for twisting cotton or other fibrous substances."—18th.

Alfred Vincent Newton, 66 Chancery Lane, London, mechanical draughtsman,—"Improved machinery for manufacturing shot, and other solid balls." (Communication.)—18th.

IRISH PATENTS.

Sealed from 1st *January*, 1848, *to* 5th *March*, 1848.

Elias Robinson Handcock, 10 St. George's Terrace, Kensington, Middlesex, esquire, and John Macintosh, Bedford Square, Middlesex, esquire,—"Certain improvements in engines to be worked by steam or other suitable fluid, and in propelling carriages and vessels."—January 12th.

Jules Jean Baptiste Martin de Lignac, Portland Street, Middlesex, gentleman,—"Improvements in preserving milk."—February 5th.

Thomas Hunt Barber, King Street, Cheapside, City of London, gentleman,—"Improvements in propelling vessels," being a communication.—5th.

Hector Sandeman, Tulloch Bleachfield, county of Perth, bleacher,—"Certain improvements in the materials and processes employed in dressing, clearing, scouring, and bleaching certain textile fabrics, and the materials of which such fabrics are composed."—5th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from January 1st, 1848, *to March* 15th, 1848.

January 1st, No. 1308. Richard Inwood Cameron, 12 Darlington Street, Clerkenwell,—"Braces."

4th, 1309. Francis Baildon Overton, Walsall,—"Revolving safety-stirrup."

— 1310. Henry Edward Thompson, Long Acre,—"Stands for military tables, washstands, and other articles of furniture requiring similar stands."

4th, 1311. William Sims, Lower Easton, near Bristol,—"Improved chimney-pot."

5th, 1312. Joseph Bunnett, London,—"Improved effluvia-trap for sewers, &c."

7th, 1313. Marc Louis Adam Fari, 8 North Street, Knightsbridge,—"The upper part of a lamp."

7th, 1314. Alexander Haig, Stepney,—"The unum folium fan-blast or blower."

— 1315. Francis Bassano, Birmingham,—"Roof lamp for railway carriages."

8th, 1316. Etienne Isaac de Lara, 15 Little Alie Street, Goodman's Fields,—"Pocket umbrella or parasol."

10th, 1317. John Paterson, 104 Wood Street, Cheapside,—"Tronser brace regulator."

10th, 1318. Martha Norton, 72 Strand,—"Ladies' equestrian shirt."

11th, 1319. Thomas Mills, Birmingham,—"Expanding and contracting table."

13th, 1320. R. Stratton, Bristol,—"Tumbler cart for night soil, manure, gravel, &c."

13th, 1321. John T. and H. Cristy and Co., 35 Gracechurch Street,—"The gutta percha bat."

15th, 1322. Henry Martin Aitken, 8 King St., Manchester,—"Scarificator for cupping."

15th, 1323. William Herapath, Bristol.—"Universal coal gas blow-pipe."

19th, 1324. Henry Tilley, 92, Piccadilly,—"Self-acting blacking fountain."

— 1325. John and William Dent and Co., 97 Wood Street, Cheapside,—"Glove finger-end."

19th, 1326. Thomas Ball, Enfield.—"Portable suspending and revolving oven."

22d, 1327. Joseph Mappin, 32, Norfolk Street, Sheffield,—"Razor."

— 1328. Charles Jones, 15 Windmill Street, London,—"Spring fastening for umbrellas."

25th, 1329. David Green, Cosely, near Bilston,—"Box smoothing-iron and heater."

26th, 1330. J. M. Webster, 42 Brewer Street, London,—"Walking mud-protector."

27th, 1331. William Groves, Sheffield,—"Movable double-handled file."

— 1332. Thomas Edwards, 10 Market Street, Cambridge,—"Railway signal"

28th, 1333. Richard Restell, 35 High Street, Croydon,—"Fruit and seed protector."

— 1334. C. B. Bingley, 22 Great Marlborough St., London,—"Redingote over-coat."

28th, 1335. C. T. Green, Woolwich,—"Instrument to be applied to the funnel of a steam-boat, to retain the upper part secure, should the ordinary hinges give way.

29th, 1336. S. Mordan and Co., City Road, London,—"Combined letter and stamping-press."

29th, 1337. S. Mordan and Co., City Road, London,—"Label damper."

31st, 1338. C. Jerome, jun., Liverpool,—"Portable domestic cooking stove."

February 1st, 1339. John Mortimer, 16 Young Street, Aberdeen,—"Mortice and tenon-cutting machine."

2d, 1340. A. M'Laren, 20 Steel Yard, London,—"Improved range pinion and spindle."

2d, 1341. Dent, Allcroft, and Co., 97 Wood Street, Cheapside,—"Elasticated tongue piece for stocks, ties, &c."

3d, 1342. John Young, Ayr,—"Pipe tile machine."

4th, 1343. John R. Remington, Stafford,—"Improved millstone."

7th, 1344. John Thompson Wilson, Hammersmith,—"Improved chimney-top."

8th, 1345. Richard Robinson, Belfast,—"Steam-boiler water-gauge."

9th, 1346, Joseph Sherwin, 21 Norton Folgate,—"Double draft register stove."

— 1347. Abraham Abrahams, Liverpool,—"Dissolving view lantern."

10th, 1348. John Randolph Remington, State of Alabama, United States, but now of Stafford,—"Condensing and digesting coffee and teapot top."

10th, 1349. William Weston, 73 Wood Street, Cheapside,—"Aptandum shirt."

11th, 1350. James Blatch Cox, Falmouth, and Josiah Stanton, Gerrans, Cornwall,—"Improved chimney-top."

11th, 1351. George Twigg, Birmingham,—"Button."

— 1352. Bedford & Rand, 296 Oxford Street,—"Lady's saddle."

14th, 1353. Henry Jackson, 3 Little Love Lane, Wood Street, Cheapside,—"Cravat."

— 1354. Smith & Co., 5 Fell St., Cheapside,—"Bombule for medicinal purposes."

14th, 1355. Antoni Forrer, 136 Regent Street,—"Hair-guard necklace, and bracelet protector."

16th, 1356. William Davidson, Thomas Place, Gravel Lane,—"Improved fire-escape."

— 1357. W. Northern, Vauxhall Walk, Lambeth,—"Improved stoneware pipes."

— 1358. John Warner & Sons, 8 Crescent, Cripplegate,—"Improved fan or spreader for fire and garden purposes."

16th, 1359. Robert Davies, 8 Blue Cross Street, Haymarket,—"Cigar and pipe tube."

17th, 1360. Samuel White, Golden Square,—"Hat stretcher."

— 1361. Ebenezer Charles Browne, St. Albans, Hertfordshire,—"Improved pan or vessel for holding milk."

18th, 1362. M. P. P. Bourjeaurd, Dover Road,—"Elastic surgical bandage."

— 1363. Robert Yeates, City Road,—"The acute cutter."

19th, 1364. Wellington Williams, Cheapside,—"Improved shirt collar."

— 1365. T. Lambert and Son, Lambeth,—"Closet basin and trap."

21st, 1366. Meyer, Isaac, Tobias, & Co., Liverpool,—"Independent compound seconds movement."

22d, 1367. Henry Doulton, Lambeth Pottery,—"Air-tight jar and cover."

— 1368. William Williams, Bedford, and Samuel L. Taylor, Cotton End,—"Improved chaff-cutter."

23d, 1369. George Chambers & Co., Gresham Street, London,—"Pin and needle box."

— 1370. Joseph Wright, Gough St.—"Mechanical movement for carriage windows."

24th, 1371. Henry Cable, Lambeth,—"Fumi porte improved chimney-top."

25th, 1372. Joseph D. Rankin, Fermanagh, Ireland,—"Safety coat."

26th, 1373. Henry Johnson & Co., Stamford, Lincolnshire.—"Pelvipedie bath."

— 1374. Thomas Craddock & Co., Birmingham,—"Improved apparatus for working expansive steam-valves."

28th, 1375. William Hayward, Northumberland Street, New Road,—"Improved carriage lamp."

29th, 1376. Walter Thornhill, New Bond Street,—"Blade of a razor."

March 1st, 1377. Barnard Isaacs, St. James' Street,—"Improved registered trowsers."

2d, 1378. Benjamin Cogswell, Strand,—"Revolving and self-priming pistol."

3d, 1379. Doulton & Watts, Lambeth Pottery, Lambeth,—"Drain-trap."

4th, 1380. Richard Gede Marshall. Cheltenham, ironmonger,—"Inkstand cover."

7th, 1381. Mark Freeman, New Road, Streatham,—"Parts of a blow-pipe."

8th, 1382. Hunt & Roskell, Old Bond Street, jewellers,—"Safety shirt-stud."

10th, 1383. Edward Colsell Rose, Great Guildford Street, Southwark,—"Radial ring for the galleries of gas, oil, and other burners."

14th, 1384. Richard Pyne, Kennington Cross,—"Ventilating and smoke-preventing apparatus."

15th, 1385. William Jeakes, Great Russell Street, Bloomsbury,—"Day's universal simplex wind-guard and ventilator."

— 1386. William Jeakes, Great Russell Street, Bloomsbury,—"Day's universal simplex wind-guard and ventilator."

— 1387. William Jeakes, Great Russell Street, Bloomsbury,—"Day's universal simplex wind-guard and ventilator."

TO READERS AND CORRESPONDENTS.

It has been suggested to us, by a gentleman whose opinion is entitled to some consideration, that a portion of our pages might be judiciously devoted to the furnishing of ornamental designs, applicable to the useful arts. We shall be happy to follow up this idea as early as is practicable; and, in the meantime, may beg the assistance of any of our readers who may have good designs at their command, suitable for adaptation to the practical pursuits of the iron-founder, modeller, cabinet-maker, silversmith, metal-stamper, and others who are more or less dependent upon ornamental art for the carrying out of their daily operations. We shall be always ready to pay attention to any general suggestions of our readers.

Books Received.—Craddock's "Chemistry of the Steam Engine;" Rutter's "Electrical Indicator;" and Mr. Curr's pamphlet.

H. W., London.—The Polmaise system of beating has been described in numerous general works. It derives its name from the village of Polmaise, near Edinburgh, where it was first applied in a vinery. It consists simply of the introduction of air to an interspace attached to a brick stove, covered with an iron plate, whence, after being thus heated, it is forced into the hot-house.

Inventor.—He may rely upon our impartial opinion on his improvements.

Peter Simple.—His oscillating engine would work perfectly well. The design is not new, as we have seen several engines, as well as air-pumps, constructed on a similar principle.

Leipzig.—Our unknown friend is thanked for his communication, with specimens of German Glyphography. We shall notice them next month.

J. Hall, Munich.—We are obliged by his drawings, which shall have our attention.

We have inquiries for the following:—A "hand paper machine;" the "best method of making coke for smiths' fires;" and "the most economical plan for the evaporation of chemical solutions"—for crystallizing nitrate of lead, for instance.

A. Watson.—We do not see any superiority in his gold weigher, except the attachment of a parallel motion; and this might be added to the present machine.

J. Hedger.—The system of folding is no doubt a disadvantage; but there are numerous objections to his proposition. Possibly we might arrange to prepare some of the plates on thick paper, varnished and mounted, for any parties who might require them.

PRACTICAL NOTES.

STATIONARY ENGINES AND GEARING AT COWLAIRS, ON THE INCLINE OF THE EDINBURGH AND GLASGOW RAILWAY.

The relative value of the locomotive and stationary systems of working steep railway inclines, has long been considered by engineers as a nice point, and has afforded subject matter for a variety of theories and experiments. The Edinburgh and Glasgow incline at Cowlairs, affords us a valuable example of the practical results of the two, for it has tested both, and decides in favour of the stationary plan. This system was originally adopted at the commencement of the working of the line, but from the deficiency of the power of the engines and other defects in their arrangement, and more particularly from the objectionable working of the hemp rope at that time employed—these operations were discontinued in 1844, since which period, to the present date, locomotives alone have been employed. The engines, as originally constructed by Messrs. Kerr and Neilson, of Hyde-Park Foundry, were two of the high-pressure kind, with 28 inch cylinders, and 6 feet stroke, coupled. The supply of steam was derived from eight cylindrical boilers, 30 feet long, by five feet diameter, having each a flue of 20½ inches diameter; steam pressure, 40 lbs.; strokes per minute, 19.

The gearing consisted of a large spur wheel on the crank shaft, of 12 feet diameter, 4 inches pitch, 15 inches broad, and weighing 11½ tons, working into a front or first-motion pinion, of 6 feet 7 inches diameter, and a back or second-motion pinion of a similar size. The two shafts of these pinions were connected by pinions of different diameters, 8 feet and 5 feet, in order to obtain two speeds of the endless traction-rope. The main spur wheel was arranged to gear with either of the pinions on the first and second motion shafts, according as a quick or slow speed might be desired; the quick speed being obtained when the front pinion was in gear, and the slow speed when the back one was made use of. To effect this change of speed, the first motion shaft was fitted with a strong clutch coupling, and both shafts were carried by sliding pillow-blocks. In changing from the quick to the slow speed, the moveable half of the sliding clutch was slid back on the shaft, and the sliding pillow-blocks then permitted of the entire removal of the front shaft, so as to clear the teeth of the wheel and pinion; whilst, at the same time, the opposite shaft was brought forward, so as to put its first pinion into gear with the main spur wheel, and its second (a five feet pinion) into gear with the 8 feet one, fast on the main rope pulley shaft. When this double-geared system was tried, it was found that the engines were not sufficiently powerful to take up trains by the fast speed, and consequently the first motion was never employed. The main pulley beneath the line of rails was 18 feet diameter, weighing 19 tons, and having a triple groove upon its periphery; to this pulley, the drag-race for stopping the rope by a friction band was attached. From this pulley, the endless rope passed over a 15 feet double-grooved pulley, weighing 7 tons, placed in a line with the plane of the main pulley. Following the course of the rope on the ascending side, it made three half turns on the main pulley, whence it passed to the 15 feet double-grooved pulley, over which it made two half turns; thence it passed to the bogie or horizontal tension pulley, of 11 feet diameter, placed upon a carriage on rails, and having a run of 20 yards, the tension on the rope being obtained by a weight of 4 tons, attached to the carriage by a chain passing over a small fixed pulley placed over a well, into which the counter-weight descended. After making half a turn round this pulley, the rope proceeded to a 7 feet single-grooved horizontal pulley of 2½ tons weight, employed merely to reverse its direction, and thence passed to the horizontal tension pulley. This arrangement is now altered, in respect that the rope makes only one turn round the bogie pulley, and the 7 feet horizontal pulley is dispensed with, the rope being taken directly to a 10 feet single-grooved vertical pulley of 4½ tons, placed directly below the down-line of rails, between which the rope passes through the tunnel to the Queen Street station, where it turns up to the up-line by a horizontal pulley of 11 feet diameter, placed below the rails.

The rope used at the period to which we refer, was a hemp one, of 7 inches circumference; it was peculiarly liable to breakage from its great friction upon the guide-pulleys, and the injurious action of moisture. This, together with the want of power of the engines, led to the abandonment of the system in 1844. From that date until a few weeks back, the incline has been entirely worked by powerful locomotives built for the purpose at the Cowlairs workshop, by Mr. Paton, the superintendent of the locomotive department.

The employment of locomotives on tunnelled inclines so steep as this, which is 1 in 42, is attended with two great disadvantages—the slipping of the driving-wheels, and the nuisance of steam and sulphuric vapour, which cannot be easily got rid of. The heavy locomotives adopted by Mr. Paton performed their duty very well with light trains, which they took up the incline at a high rate of speed; but when attached to long trains, the objectionable slipping of the wheels, and the disagreeable state of the atmosphere in the tunnel, resulting from the slow passage through of the engine, were condemned as intolerable. The stationary engines, which had been retained with the view of working the tunnel on the atmospheric principle—had that system been successful—were then again looked to as a means of avoiding these evils, and they have been accordingly refitted, under the superintendence of Mr. W. M'Naught, who has added to their power by the substitution of larger cylinders, and by various minor alterations in their details. The gearing and rope apparatus has also undergone considerable changes, under the superintendence of Mr. Paton, to whose politeness we are indebted for the particulars of the improvements he has introduced.

The original boilers have been retained, but have been re-set, and the flues have been narrowed and deepened, so as to permit the flame and heated air to act more freely upon the boiler surface. The furnace bars, originally 1½ inches thick, have been replaced by a set ⅝ inch thick, and proportionally deeper, and are set at a considerable angle in the furnace. The area of the chimney has been increased from 9 feet to 25 feet, and the draught, which was formerly defective is now so far improved as to permit of the entire use of culm or small coal in the furnaces.

The boilers are placed immediately behind the engine-house at the head of the incline; and a range of pipes, 10 inches in diameter, conveys the steam to a central double-beat stop-valve, placed immediately behind the pair of cylinders. This valve is worked by a screw spindle connected by bevil gearing, with an arrangement of shafting passing beneath the floor to the starting hand-wheel, which is on a vertical spindle, placed in the recess of the engine-house window, so that the engineer can see down the incline whilst he is handling the engines. The bottom of the chest of this stop-valve has two opposite branches, each fitted with a separate stop-valve, whence pipes lead off to the nozzles of each cylinder; by this arrangement the steam may be shut off from one or both engines at pleasure. The new cylinders, which were supplied by the St. Rollox Foundry Company, are 36 inches diameter—the stroke remaining the same as before. The waste steam from the engines, instead of being discharged directly into the atmosphere, is blown into a heating chest employed for heating the water for supplying the locomotives on the line. Fig. 1, is a side elevation of this heating chest, partly sectioned to show its interior arrangement. Fig. 2, is a ground plan, showing the cover broken, for the same purpose. *a a*, is the water tank, which is carried by massive transverse girders on the top of the engine-house. *b b*, is the heating-chest of cast-iron; it rests upon the bottom of the water tank, being placed transversely across it; it is open at the bottom to the containing tank, and has, near the top, a horizontal division running the whole length of the chest, so as to sepa-

rate a space, *c*, near the top, from the remainder of the chest. A vertical division runs down the centre of the chest, so as to divide the whole chest into two parallel lengths, as represented more clearly in the ground plan. A 12 inch pump worked by each engine supplies the feed-water for the tank by the pipe, *d*, which opens into the upper chamber, *c*, *c*. A series of narrow transverse openings, *e*, are made at intervals in the division of the upper chamber, and through these openings the feed-water falls in sheets to the lower portion of the heating-chest. The waste steam from both cylinders is conducted by the pipe, *g*, through the upper chamber *c*, and is discharged into the lower part of the chest above the water line, *h*, of the tank. In this way the steam passes along the first length of the chest, between the division of the chamber, *c*, and the surface of the water, and is thus compelled to pass through the several sheets of water falling through the series of openings, *e*. After passing along the first length, the condensing steam and water passes round the end of the central division, as shown by the arrow in

Fig. 1.

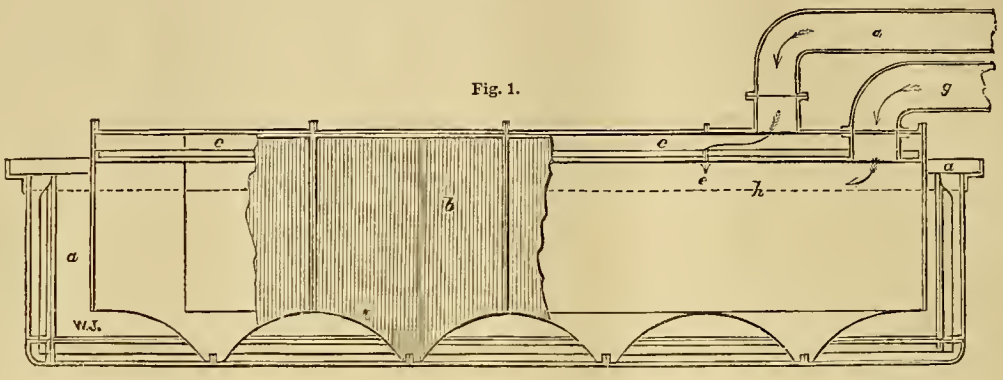
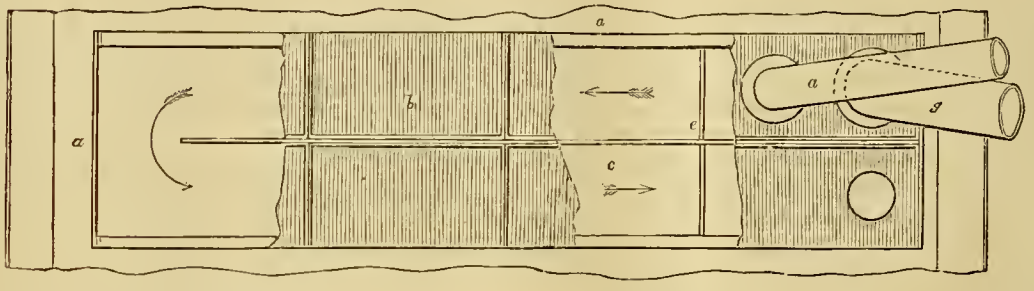


Fig. 2.



the ground plan, and thence along the second length, the partially condensed vapour and air escaping by the opening, *k*, whilst the heated water circulates through the tank by the curvilinear openings cut in the bottom edges of the plates of the heating-chest. A mercurial steam guage is placed within view of the engineman, in the engine-house below, by which he can at any time note the exact pressure of the steam in the boilers, and whenever it exceeds the working pressure, he opens a blow-off valve, and discharges all the surplus steam into the tank, so as to economise the heat to the utmost. This arrangement is found to be a most economical one, as the water in the tank is kept heated to from 150° to 180°, and thus an immense amount of fuel is saved in the consumption of the locomotives, as compared with the use of cold water for the supply of the tenders. A small auxiliary engine, with an 8 inch cylinder, feeds the boilers by means of two force-pumps; this is only done when the engines are standing, so that the steam pressure in the boilers is maintained with little diminution compared with what would result from feeding during the action of the engines.

The rope gearing has been very much simplified, and is now in a most efficient state. The new main spur-wheel on the crank-shaft is 9 feet 6 inches diameter, 18 inches broad on the teeth, 4 inches pitch, and weighs 6½ tons. It gears with a similar wheel on the main pulley shaft, 12 inches diameter, which thus receives its motion direct, without any other gearing whatever. The arms of both these wheels are ribbed on each side, in place of having a single central rib; they are the production of the works of Messrs. Randolph and Elliot, and are deserving of great praise as excellent specimens of smooth working gearing. The drag-race, or friction-pulley, has been removed from the main rope pulley, and its place is supplied by two races, placed one on each side of the second spur-wheel. A malleable iron friction-strap, lined with copper on its inner side, to give it energy in bringing up the gearing, is fitted to each of the races. Each strap is worked through a powerful lever attached to the piston-rod of a small vertical steam cylinder placed in the pit of the gearing. The stop-valve in the supply-pipe of this cylinder is connected with a hand-lever placed near the starting wheel of the main steam-pipe, so that the engineman can immediately apply the break without moving from his position.

The main rope pulley has been fitted with a turned grooved rim, cast in two halves—it having been found that the inaccuracies of the surface of the unturned grooves frequently caused the rope to leave the pulley. Its diameter is 18 feet, and weight 7½ tons; the rim was made at Birmingham, by Messrs. Fox, Henderson, and Company, of the London Works and is an excellent specimen of workmanship.

The rope now in use is a wire one, manufactured by Mr. Newall, of Gateshead; it is 4⅜ inches in circumference, weighing 19 tons; it consists of six strands, each composed of six wires; these wires are twisted round a light strand of hemp, which forms the nucleus of the rope, and adds to its flexibility. The rope is supported, in its passage between the rails, upon iron pulleys about 18 inches diameter. They are fitted up with wrought-iron spindles, running in brass bearings fixed in small cast-iron boxes set in the ground between the rails, about 30 feet apart. One of Cooke and Wheatstone's six-wired electric telegraphs is employed for communicating between the Queen Street station at the foot of the incline, and the stationary engine-house at the top. The index table and working levers at the upper end are placed near the starting-wheel

of the engines, so that, when the attention of the engineer is attracted by the ringing of the alarm-bell, he can immediately prepare or start his engines, according to the instructions of the officials at Queen Street.

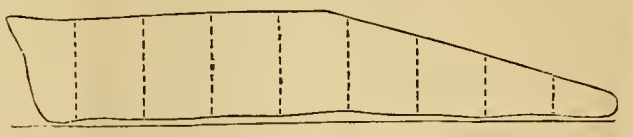
The systematic and exact arrangements attending the dispatch of the trains is such, that no detention—not even any perceptible change in speed—takes place at the conclusion of the duty of the stationary power, and the passenger is unaware of the employment of any other agent in his conveyance than the locomotive alone. Previous to the departure of each train, the locomotive intended for its conveyance is sent down the incline, and attached to it. When all is ready, the telegraph-man at the station signals the engineman at Cowlairs to go on; and, at the same time, the driver of the locomotive puts on his steam in a small degree, so as to assist the ascent of the train. The engineman at Cowlairs then watches the approach of the train, and shuts off the steam from the stationary engines, and applies his break shortly before the train arrives at the termination of the rope. So soon as the speed of the rope becomes less than that of the train, the latter detaches itself,—the locomotive driver puts on his steam, and the train continues its journey.

The detaching arrangement of the messenger rope, which is of so much importance to the accurate working of the system, consists simply of a link or ring of metal, which is hung on an inverted hook, with an inclined entrance, attached to the front buffer bar of the locomotive. The messenger rope is only a few feet in length, and is attached to the wire traction rope by means of a few loose strands which are lashed back and forward upon it for a length of about two feet. On starting, the link on the extremity of the messenger rope is simply slipped upon the front drag-hook of the locomotive, and retains its place so long as the strain from the traction rope continues; but immediately that the steam-break of the stationary engines is put in operation, and the traction rope diminishes in speed, the momentum of the train carries it forward, and the link of the messenger rope slips from the inclined entrance of the inverted hook on the buffer bar; the train goes on, and the breaksman detaches the messenger rope, and carries it to the foot of the incline for future use. As a precautionary measure, two breaksmen, with each a break waggon, are sent up the incline, attached to the last carriage of each train. On arriving at the top, the front breaksman slips the rope which attaches his waggon to the train, and the two waggons return down the incline alone. As a means of prevention of accidents by over-drawing the trains at night, or in foggy weather, when the engineman cannot make out the position of the train distinctly, it is intended to put up a counter in the engine-house, so that, by referring to its dial, the number of strokes of the engines, and the consequent position of the train upon the incline, may be accurately ascertained. As the wire rope has a perfect hold upon the main pulley, there is no risk of derangement of the counting apparatus by slip.

The time occupied by a train in passing up the incline, which is 1½ miles long, is from four to five minutes, according to the weight taken up. We timed our own trip, and found it to be four minutes twenty seconds, from the time of leaving Queen Street station to that of our arrival at the stationary engine-house—the train consisting of a dozen passenger carriages and the two break-waggons. During our upward journey, we witnessed a noticeable instance of nerve and quickness of motion on the part of one of the servants of the company, who was standing next us on the break waggon. When about two-thirds of the way up, a gust of wind carried away the man's cap, when he immediately let himself quietly down the side of the waggon, and leaped to the ground with his face in the direction of the train's motion; and, although our speed at the time could not be less than eighteen or twenty miles per hour, by inclining his body backward at a very considerable angle, and running forward with short steps, he gradually destroyed the momentum he had acquired, and recovered himself.

As a means of obtaining data regarding the power required to work the rope gearing, and to convey trains of given size up the incline, we had taken for us, by Mr. M'Naught, during our visit, a series of indicator diagrams, which we have engraved, as illustrations of these most important points.

ENGINES DRIVING WIRE ROPE, AND GEARING ALONE.

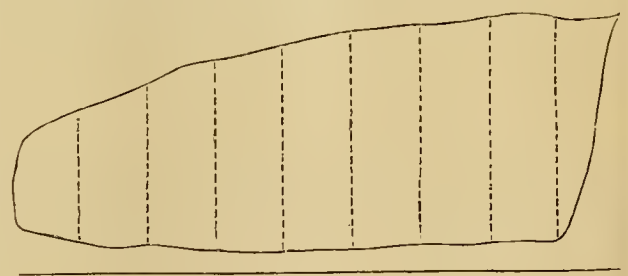


10·8. 11·0. 11·5. 10·8. 11·4. 10·3. 7·9. 5·8. 3·8.

9·23 lbs. average effect on Piston.

This diagram is to a scale of 20ths—that is to say, every 20th of an inch measured on the vertical dotted lines indicates a pound of pressure on the piston. It was taken during the working of the engines and rope gearing alone, and shows exactly the amount of power required to move them; or in other words, that the amount of friction involved in their motion is equal to 9·23 lbs. per square inch of one piston, or 18·46 lbs. including both engines. Then, deducting 2 lbs. per square inch for the friction of each engine, we have 14·5 lbs. nearly, absorbed by the rope and gearing; this, at the rate of 25 strokes per minute, employing Watt's standard of 33,000, gives 126 horse-power as the amount required to drive the rope and gearing, exclusive of the engine's own friction. Different experiments have shown, that 3½ lbs. pressure on each piston is required for the engine and gearing, exclusive of the rope; so that we have here data for accurately obtaining the loss by friction under all circumstances. During the working of the hemp rope, the friction was ascertained by repeated trials to be equal to 112 horse-power at 19 strokes per minute; and if we take the same case at 25 strokes, as now working with the wire rope, we have 147 horse-power absorbed by this portion of the machinery, leaving a very considerable balance in favour of the wire rope, although it weighs 19 tons, and the hemp one weighed only 11 tons.

ENGINES DRAWING A LIGHT MAIL TRAIN OF TEN CARRIAGES.



12·6. 16·4. 19·4. 21·5. 22·8. 23·0. 23·4. 24·8. 20·4.

20·43 lbs. average effect on Piston.

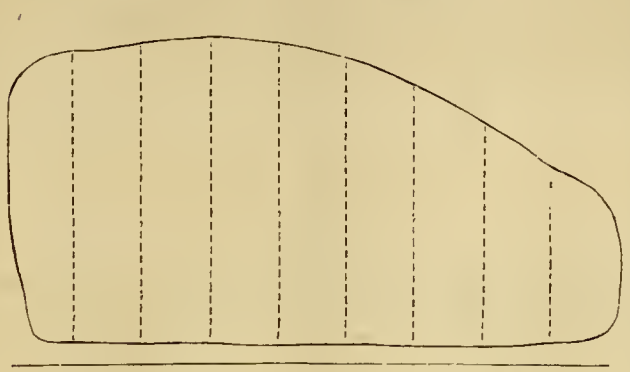
This diagram was taken from the lower side of the piston, and the figure is consequently reversed. The average pressure required is 20·43 lbs. on each piston, which, at the average speed of 25 strokes per minute, gives 320 horse-power as the effect required for giving motion to the gearing, rope, and train, deducting 2 lbs. for friction of engine, and 5 per cent. on the whole power for labouring friction, being the increase arising from the pressure of the working parts in moving the train.

The following is an excellent square diagram, and, when compared with the long narrow figure given by the engines when driving the rope and gearing alone, shows, in the most striking manner, the different expenditures of labouring force for given results.

The average pressure (28·71 lbs.), calculated as before, gives 464 horse-power—the speed being 25 strokes per minute. Taking the results of previous experiments at 3½ lbs. for driving the engines and gearing as far as the main pulley, we find 1½ lbs. to be the amount

required for the main gearing, deducting 2 lbs. as the ascertained friction of the engines.

ENGINES DRAWING GOODS' TRAIN OF THIRTEEN WAGGONS.



30·0. 32·1. 32·9. 33·5. 32·4. 30·0. 27·9. 23·0. 17·3.

28·71 lbs. average effect on Piston.

The slight upward curve shown in the lower side of the first and third diagrams, is owing to the back pressure on the piston, arising from the discharges of steam from the one cylinder affecting the exhaust of the other. As both engines exhaust into one pipe, the first discharge of one cylinder, when its crank is on the centre, acts in a small degree upon the exhaust side of the piston of the other one, which is then at half stroke.

We may remark that the present consumption of fuel is considerably less than before the re-arrangement of the works, although the traffic is at least one-half more. This result has been attained by the several improvements of the furnaces and flues of the boilers—the correct arrangement of the valves of the engines—the simplified modification of rope gearing—and the adoption of the wire rope. The present system of working the incline may fairly meet comparison with any existing work of a similar nature. Indeed, we are by no means certain that, taking all the circumstances into consideration, there is one other instance of such extreme regularity, precision, and dispatch, elsewhere.

SIMSON THE MATHEMATICIAN.

High amongst the worthies whom Glasgow reckons as her own, stands Robert Simson, the learned mathematician, best known as the editor of Euclid's Treatise on Geometry. His grandfather held the office of Dean of the Faculties in the University, and his father was a merchant in this city; but he was born at Kirton Hill, in Ayrshire, where his family had an estate, on the 14th of October, 1687. Little or nothing is known of his school days. It appears that he was intended for the medical profession, but afterwards changing his plan, he studied for the church, in the university of Glasgow. He applied himself diligently to the classical languages, theology, logic, and the literature of the Bible. At that time, although there was a professorship of mathematics in the university, and a salary attached to the office, yet the person who occupied the chair never delivered lectures or held a class. Simson being desirous of knowing something of the science, procured a copy of Euclid, and finding the study tally with his taste, he read the book with so much diligence, and became by his twenty-second year so well grounded in mathematics, that the academic senate offered him the appointment of professor at the next vacancy, it being supposed that a vacancy would shortly occur. With a view of making himself more familiar with the science, before undertaking so important a charge as he justly considered it, he proceeded to London, where he became acquainted with Halley and other celebrated mathematicians. During his stay in London, the chair became vacant, and he was immediately appointed professor, in 1711. He at once opened two classes, and taught them five days a-week, for seven months in the year, a duty he fulfilled for fifty years. It is said, that although geometry was always his favourite study, he was no mean algebraist, and he was versed in astronomy, and other branches of the mixed mathematics. He was fond of botany, as many other skilful mathematicians have been, and amused himself during his walks with gathering and examining flowers.

Among his colleagues during the long period of his teaching, were Adam Smith and Hutcheson, famous for their writings on moral and political science, and Black, the chemist. Professor Robison and Dr. Traill were perhaps the most distinguished of his pupils. His lectures are said to have been characterised by great clearness, elegance, and a good delivery. He was a favourite with his pupils, on account of the zeal with which he superintended their studies, readily assisting them in private to overcome their difficulties.

The success with which the ancients prosecuted the study of geometry, must ever be regarded as one of their greatest triumphs. Whether or not we are to look upon Egypt as the cradle of this, as well as of most other sciences, it must be admitted that the Greeks carried it to greater perfection, as far as we know, than any other people; esteeming it as one of the noblest subjects the human mind can employ itself upon. In truth, it was the very subject to interest men who love harmony and formal beauty, almost with the strength of a passion. The simplicity and stability of its foundations, the mode in which the mind can travel along a chain of irresistible reasoning without once coming into contact with the external world, the elegance of the processes, and the perfection of the proof,—all these circumstances combined to attract the Greek philosophers to the cultivation of a science which required no laborious collection of facts, no careful sifting of differences or evidence, no patient comparison of observations, nothing in short but a calm exercise of reason, and which was therefore equally free from change in the structure and doubt as to the result. We find, accordingly, that their profoundest thinkers applied themselves to its culture, with a devotion that showed how it harmonised with their taste. Many of their treatises are lost, but some have survived, the most valuable being works by Euclid and Apollonius. The greater part of a treatise called Mathematical Collections, written by Pappus, a mathematician of the Alexandrian school who lived in the fourth century, has also come down to us. The writer enumerates at considerable length the geometrical works of the elder Greeks, giving in several instances a summary of the contents, and even of the propositions. He thus mentions a work of Apollonius, known as the *Loci Plani*, comprehending propositions, which treat of loci to the circle, and rectilinear figures. Before Simson's time, two mathematicians had given the world restorations of the lost work, but their editions were extremely unsatisfactory, inasmuch as one had supplied purely algebraic demonstrations, whilst the other confined himself to general solutions, and neither had given the analysis. Simson then returned to the work, and he succeeded in filling up the blank. It is said, indeed, that his treatise is superior to the origin alone of Apollonius, for he has unfolded many important truths which the Grecian had not touched. Certainly he has exhausted the cases of each proposition, and has enunciated the solutions with elegant precision. He completed this work in 1738, but kept the manuscript by him for eight years, having doubts whether he had been able to render truly the order and spirit of Apollonius. At length he consented to place the work in the hands of a printer, but his doubts recurred with greater force, and he withdrew it again. Three years more elapsed, and then in 1749, the Loci Plani appeared. During this period, the professor had restored another work of Apollonius, that on Determinate Section, or the propositions which respect the properties of the squares and rectangles of segments of lines passing through given points. In this work, Simson had also two predecessors, but neither of them had succeeded in doing what they attempted; and, indeed, one of them had restricted himself to a part of the subject. Simson's restoration is complete and excellent.

He next applied himself to an edition of Euclid's Elements of Geometry, the original Greek of which had been preserved, and he produced a work which is held in the highest estimation, for to this day Simson's Euclid keeps possession of the schools. It came out in 1758, and to the second impression, published four years afterwards, he added the Data, another treatise of Euclid. He revised the text of these treatises with great pains, and took much trouble in collating the previous editions, and in consulting commentaries.

Among the works of Euclid, enumerated by Pappus, were three books on *Porisms*, a subject upon which mathematicians fruitlessly exercised their ingenuity in after times. Porism was defined by the geometers of the later Greek school, to be a proposition differing from a local theorem, by a defect or omission in the hypothesis, but it has been objected that this definition is imperfect, on the ground of not being co-extensive with the thing defined. Indeed, we do not know that scientific men have yet agreed upon a definition. One of the latest writers we have consulted, says, "Perhaps we may accurately enough define a porism to be the enunciation of the possibility of finding that case in which a deter-

minate problem becomes indeterminate, and admits of an infinity of solutions, all of which are given by the statement of the case." The account given by Pappus, and his work contains the only source of our knowledge, is extremely meagre, being limited to a few sentences in the introduction to his seventh book; moreover, the difficulty arising from brevity, was increased by the corruptness of the Greek text. Speaking of Euclid's treatise, he calls it a very curious collection of many things, concerning the solution of difficult and general problems, and then he defines a porism to be something between a theorem and a problem, in which, instead of anything being proposed to be done or proved, something is proposed to be investigated; but this definition is so vague and loose, that it may fairly be considered none at all. This obscure subject had been approached by various men of science. Albert Sirardus, in 1635, stated that he had been able to restore Euclid's treatise, but no work of his ever saw the light. Halley had been foiled in unravelling the matter, as he candidly confessed. In D'Alembert's contributions to the Encyclopedie, porism is treated as synonymous with lemma; a gross blunder, which shows that the writer had not referred to Pappus's book. Fermat, a French mathematician of eminence, was the man who, of all Simson's predecessors, had made the best attempt to solve the difficulty. He made a promise to restore the whole three books of Euclid; but he only published five propositions with demonstrations, and when he comes to the general definition, it is clear that he remained ignorant of the true nature of a porism.

Dr. Simson directed his attention early in life to this puzzling matter, and bent his mind so intently upon it, that for a long time his thoughts were entirely occupied by it, and even his sleep was disturbed. At length his health began to suffer from the tantalising pursuit, which seemed doomed to end in disappointment, and he resolved to drive it altogether away from his thoughts. In April, 1722, however, he happened to be strolling with some friends near the Clyde, and had fallen behind them in a fit of musing. The topic which had given him so much trouble again intruded, and all at once an idea struck him, which he felt convinced would afford a key to unlock all his difficulties. He paused at the stump of a tree that stood by the path, and with a piece of chalk sketched a figure upon it to assist his considerations. He shortly afterwards drew up a short paper, which he published in the Philosophical Transactions for 1723. Having thus got in the wedge, he continued to work on the subject at his leisure time, conversing with his pupils and corresponding with his friends upon the difficult points. In the end he completed a methodical treatise, which he kept by him in manuscript until his death, and it was then published at the expense of Earl Stanhope, who is favourably known to the world as a munificent patron of science, as well as an original inventor. Some other treatises swelled the volume, but that on porisms occupies 277 pages. It comprises ninety-eight propositions, four being problems, ten loci, forty-three theorems, four lemmas, and thirty-five porisms. The whole is prefaced by an introduction in which the general subject is discussed with luminous conciseness. The reason he did not print the treatise in his lifetime, was the same that retarded the publication of the Loci Plani, a belief that it was not so perfect as it ought to be. It is admitted on all hands, that the work is a very masterly performance. His investigations are conducted with all the rigorous precision of the Greek geometers, and the propositions have singular beauty. If we may judge of its merit by the difficulty overcome, and the originality of the performance, this must be called Simson's masterpiece.

Little more remains to be added to this sketch of the professor, and that little relates only to his private life. Pursuing his vocation with unabated attention, and confining himself to philosophic studies, few circumstances occurred unconnected with them, to break the even tenor of his days. Once a week he attended the meeting of a club at Anderston, where the members dined. He delighted in music, but his vocal performances did not deviate far from the staidness of his usual employments. He was wont now and then to join a Greek ode to a melody of slow movement, and he has been heard to sing a Latin hymn to the Divine Geometer, with a voice not ill adapted to a solemn strain, until tears of rapture stood in his eyes. He liked to take a hand at whist, and to calculate the chances of the game. That he generally failed in doing this correctly, able mathematician as he was, is a parallel story to that of the geographer who lost himself on a common. He was never married, and like most bachelors he fell into those nice and punctual ways which are apt to draw a smile from men who have yielded up their liberty. For instance, he would measure the quantity of exercise he took, by counting the steps of a walk; and, when interrupted in the calculation by the address of a friend, he has been heard on parting to give out aloud the number at which he recommenced his perambulation. There are several anecdotes of his absence of mind, but notwithstanding this, he was a good man of business. He held the office of clerk of the Faculty in his university for thirty years, and executed its duties with punctuality. He died on the 1st of October, 1768, having enjoyed the blessing of health unimpaired, up to within a few weeks of his departure. He gave his manuscripts and library to the university. He left a name that will be mentioned with deep respect by those who are capable of estimating the services he rendered to mathematical science. We will only add, that the life of Robert Simson affords another proof that abilities short of the highest class, may succeed in realising noble aims if properly backed by industry and perseverance.

DISCOVERY OF A NEW ACID AND ALKALINE SALT, OBTAINED FROM THE EUPHORBIA OFFICINARUM.

By Mr. R. Smith, Blackford.

The Euphorbia Officinarum is a member of a numerous family, the Euphorbiaceæ of the system of De Candolle, in which list are also to be found the Buxus Sempervirens, or box-tree, the Castor oil plant, and the Jatropha Manihot, or Cassava plant.

In order to obtain the acid, which the author has termed the Euphorbic acid, the plant is cut in small pieces, which are digested in water at a gentle heat, for three or four hours; after which it is filtered, and a solution of the di-acetate of lead is added to the filtered liquid, as long as precipitation continues. It is then again filtered; the precipitate being preserved, the liquid contains the alkali, and the precipitate the acid. The precipitate is then washed and diffused in water, and a stream of sulphuretted hydrogen gas is passed through it, when a precipitation of sulphuret of lead takes place. It is then filtered a third time; and the liquid passing through the filtre contains the acid, which is colourless, and perfectly transparent. It does not redden litmus paper: it is bitter, and slightly sour to the taste; and, if allowed to remain on the tongue for some time, it produces an acrid painful sensation. With a solution of di-acetate of lead, it forms a dense white precipitate: it precipitates lime water, and chlorate of tin; but no precipitation ensues when added to solutions of sulphate of iron, nitrate of silver, sesquichloride of iron, or chloride of barytes. It combines with a few of the alkalis, forming salts; and, as it differs materially, in its composition, from all vegetable acids hitherto known, the author has named it after its parent plant.

In order to obtain the alkaline principle, the filtered liquid of the first process is evaporated down to a fifth part of its bulk, and is set aside to cool, when a deposition of small brilliant crystals takes place. The acetic acid contained in the di-acetate of lead of the first process, combines with the alkaline principle of the plant, forming an acetate, which the author proposes to name the "acetate of euphorbine." Upon evaporating the liquid remaining after crystallization, a brownish gum is deposited; this gum is soluble in sulphuric acid, producing a deep red colour, arising from the action of the acid on the chlorophyle or colouring matter of the plant. The crystals of the acetate of euphorbine are repeatedly washed in water, and dried with blotting paper; they are beautifully white, and semi-transparent; their form is elliptic, with slight indentations on the ends. The subjoined figure is a microscopic view of the crystals, magnified 700 times; the three elliptical forms are entire crystals, the remainder being detached fragments. They are partially soluble in ether, but dissolve rapidly in nitric and hydro-chloric acids, but slowly in sulphuric acid, and are insoluble in water and alcohol.

A solution of nitrate of silver in ether, added to an etherial solution of the salt, gives a white precipitate. Sulphate of iron and chloride of mercury, produce no precipitation. A small dose of this substance administered to an animal, destroys life, producing dilatation of the pupil of the eye, drowsiness, paralysis, and coma.

REPORT OF EXPERIMENTAL INVESTIGATIONS ON COALS, FOR THE STEAM NAVY.

By Sir H. De La Beche, and Dr. Lyon Playfair.

[A voluminous report on this all-important subject, has been lately presented to both Houses of Parliament by royal command. It has been prepared with the greatest attention to accuracy, and the experiments have been so complete as to render the result of the highest value, as a guide for the engineer in all circumstances attending the choice and management of fuel. We trust we have nothing further to urge in favour of its introduction into our pages *in extenso*.—En. P. M. J.]

The qualities for which particular kinds of fuel are pre-eminent, being so varied, it is impossible to deduce general results from a limited series of observations. Even in the one economical application of coals, their evaporative value, or their power of forming steam, one variety of coal which may be admirably adapted from its quick action for raising steam in a short period, may be far exceeded by another variety, inferior in this respect, but capable of converting a much larger quantity of water into steam, and therefore more valuable in the production of force. A coal uniting these two qualities in a high degree might still be useless for naval purposes, on account of its mechanical structure. If the cohesion of its particles be small, the effect of transport, or the attrition of one coal against another by the motion of a vessel, might so far pulverize it as materially to reduce its value. Even supposing the three qualities united, rapidity and duration of action with considerable resistance to breakage, there are many other properties which should receive attention in the selection of a fuel, without the combination of which it might be valueless for our steam navy.

There is an important difference existing between varieties of coals in the bulk or space occupied by a certain weight. For the purposes of stowage-room this cannot be ascertained by specific gravity alone, because the mechanical formation of the fragments of coal may enable one of less density to take up a smaller space than that occupied by another of a higher gravity. This is far from an imaginary difference, being sometimes as great as 60 per cent., and not unfrequently 40 per cent. The mere theoretical determination of the density of coals would, therefore, give results useless for practice. The space occupied between two varieties of coal, often equally good as regards their evaporative value, differs occasionally 20 per cent., that is, where 80 tons of one coal could be stowed, 100 tons of another of equal evaporative value might be placed, by selecting it with attention to its mechanical structure. These facts are mentioned merely to show that a hasty generalization should not be made, and to account for our drawing attention to these various points as a means of preventing the selection of a fuel from any one quality. We do not, in the present state of this inquiry, consider it proper to offer any recommendation of our own as to particular kinds of fuel, leaving the experimental facts to decide for themselves.

After preliminary experiments had proved that no practical result could be attained by mere laboratory research, it was determined to test each variety of coal on a scale of sufficient magnitude to check the theoretical views by the practical results. As it was impossible for either of us to devote our whole time to this inquiry, our services being required by other official duties, we appointed assistants to superintend its special parts, under our general direction. On the selection of assistants we have reason to congratulate ourselves, their duties having been conducted with great care and skill. To Mr. Wilson, since appointed Principal of the Royal Agricultural College of Cirencester, whose practical knowledge well fitted him for the task, the superintendence of the economical part of the experiments was first confided. To him and Mr. Phillips is due the erection of the boilers, and the experiments to illustrate the practical evaporative power of the coals. After Mr. Wilson had for some time proceeded with the investigation, he was joined by Mr. Kingsbury, who volunteered his services to this department. The latter gentleman was formerly a distinguished student at the College for Civil Engineers, Putney, and from his engineering skill, has rendered an especial service to this inquiry.

On the translation of Mr. Wilson to Cirencester, the practical superintendence of the investigation was intrusted to Mr. J. Arthur Phillips, a pupil of the Ecole des Mines of Paris. The information obtained had pointed out improvements and corrections in the processes used, to which Mr. Phillips applied himself with much skill and success.

The corrections and the results of his experiments will be found in his appended report. The excellent scientific education of Mr. Phillips and his practical resources, rendered his services of great value.

The analyses of coals were intrusted to Mr. Wrightson (a pupil of Liebig), who had fitted himself by special study for an undertaking requiring so much delicacy of manipulation. Mr. Galloway, an assistant at the Museum of Practical Geology, gave his occasional services in analyzing gases and ashes from the furnaces; but he was not wholly retained for this purpose.

Mr. How, a very careful experimentalist, and assistant at the laboratory of the College for Civil Engineers, was appointed analyst after the retirement of Messrs. Wrightson and Galloway.

It is proper to mention, in terms of approbation, the services of the intelligent working engineer, William Hutchinson, whose assiduity soon enabled him to be of more important service than was to have been expected from his position. The results obtained by the assistants, with accounts of the modes pursued, are appended, in order that the methods may be examined, and that special attention may be devoted to any particular department of the inquiry.

In the first section of the appendix, a full description is given of the processes adopted in conducting the practical part of the experiments, as also plans and sections of the boiler, furnace, and apparatus employed.

The second section contains details of the observations and experiments made to ascertain the evaporative power of the different varieties of coals.

The third section describes the formulæ used for calculating the experiments, and for correcting and reducing them to one standard.

The fourth section contains the chemical experiments, including the ultimate and proximate analysis of the coals, and the determination of their calorific values.

It is unnecessary to repeat here the mode in which the experiments were instituted, as these are detailed in the first section of the appendix, so that it will suffice to draw attention to the points observed, in reducing and calculating the results. It will be obvious that there are several circumstances which must receive attention before the true evaporative value of a fuel can be obtained. Thus, the water in the tanks has a varying temperature during the day, dependent on atmospheric changes, and is always different from that in the boiler. The temperature of water in the boiler also varies with the external temperature, and the circumstances under which the experiments are made. The shape of a Cornish boiler favours an inequality in the temperature of the water in its various parts, the colder and denser water sinking to the bottom, and having a tendency to remain there; so that the temperature of water at the surface is far from being the mean temperature of water in the boiler, the difference between the surface and bottom water being, on an average, 70°. Other circumstances naturally affect the evaporative powers of the coal; as, for example, the fact that all the water exposed to the action of the fire in the boiler is not converted into steam, and that wood is used to light the fire. Another circumstance of considerable importance, is the expansion or contraction of the boiler from an increase or diminution of the temperature. In the early stage of the experiments, those conducted by Messrs. Wilson and Kingsbury, it was thought unnecessary to make a correction for this variation in conditions; but, on ascertaining experimentally that the difference was as much as 69·625 lbs. of water in the contents of the boiler, between the temperature 150° and 212°, it became desirable to make an allowance for it, even when the difference between the initial and final temperature was not greater than 10°. Other circumstances of less importance, but influencing the results, have been neglected, because the application of such corrections would have only complicated the results, and would have had little practical value, when the errors of observation in such approximative experiments remain so large. Among those may be mentioned the quantity of gases evolved during combustion, the elevation in temperature of the air entering the fire-place, the barometrical and hygrometric conditions of the atmosphere, the radiation from the boiler (very small in amount, owing to its brick covering), the hygrometric state of the fuel, or the heat necessary for obtaining mechanical draught in the chimney. In most of these cases the necessary observations have been made, to enable the corrections to be applied, should it afterwards appear desirable.

In making the calculation for the evaporative value of a fuel, the quantity consumed was divided into two portions, the first being that necessary to raise the whole mass of water exposed to the fire, from the *mean temperature* to 212°, the second portion being that required to evaporate the water taken from the tanks from a temperature of 212°. To enable this to be done, the mean temperature of the whole mass of the water is ascertained—that is, the temperature of the water in the boiler at its initial temperature, after being mixed with the tank water at its average temperature. The average of the latter was the mean of several observations taken during the day, and is designated by t'.

Let w be the weight of water drawn from the tanks at temperature t'
W " in boiler " t'', this being obtained from surface temperature corrected by experiment.
t temperature after mixture.

$$\text{Then } t = \frac{\mathrm{W}\,t'' + w\,t'}{\mathrm{W} + w}$$

The correction for the wood was made from data procured experimentally by Messrs. Wilson and Kingsbury, but it can only be employed for the particular wood used, as in subsequent experiments the evaporative value was found very different from another quality obtained. The co-efficients of the evaporative power of the wood may be deduced from experiment, in which a certain weight of water was raised from a known temperature to the boiling point, and then a certain portion of it evaporated. The following formulæ have been used by Mr. Kingsbury for the calculation:—

N is the total weight of wood used in raising $W + w$ (the weight of water in the boiler, and of that let down from the tanks during the experiment) from the mean temperature t to 212°; then it is necessary to find the weight N′ necessary to evaporate w from 212°.

Then $\frac{w}{N'} = e$, the evaporating power.

Let m be the weight of wood required to raise $W + w$ from t to 212°, the number 1000 being assumed as the latent heat of steam.

N to evaporate $W + w$ from 212°
N′ " w "

Then $m + N' = N$.

Now $\frac{l}{212 - t} = \frac{n}{m}$

But $\frac{n}{N'} = \frac{W + w}{w}$

$\therefore N' = n \frac{w}{W + w}$

$l (N - N') = (212 - t) n$

$= (212 - t) N' \left(\frac{W + w}{w}\right)$

$N l = N' \left\{\frac{W + w}{w}(212 - t) + l\right\}$

$= \frac{N'}{w} \left\{(212 - t)(W + w) + l w\right\}$

$\therefore \frac{w}{N'} = \frac{(212 - t)(W + w) + l w = e}{N l}$

or, introducing the value of t as given by the first formula,

$$\frac{(t + 212 - t) w + (212 - t',) W}{N l} = e.$$

If q be the quantity of wood used in lighting the fire, $e q$ will be the weight of water evaporated from 212° by the wood, and must be deducted from the weight of water evaporated in calculating the work done by the coal.

The coefficient of the evaporating power of the coals, or the number of pounds of water which one pound of coal will evaporate from 212°, may be calculated as follows:—

Let P he the total quantity of coal consumed, then the work done by P will be to raise $W + w$ of water from t to 212, and to evaporate $w - e q$ from 212°

Let m be the weight of coal required to raise $W + w$ to 212° from t,
p " " evaporate $w - e q$ from 212°
n " " " $W + w$ from 212°.

Then $\frac{w - e q}{p} = E$ the evaporating power.

Now $P = m + p$

$\frac{212 - t}{l} = \frac{m}{n}$

But $\frac{p}{n} = \frac{w - e q}{W + w}$

$\therefore = l \left(\frac{w - e q}{W + w}\right) = p \frac{212 - t}{P - p}$

$\frac{(W + w)(212 - t) + (W - e q) l}{P l} = \frac{w - e q}{p} = E$

Introducing the values from which the mean temperature t was obtained (first formula), we have eventually

$$\frac{(l + 212 - t') w + (212 - t'') W - l e q}{P l} = E$$

in which W is the weight of water in the boiler;
w " drawn from the tanks during the experiment;
t' the mean temperature of water in tanks;
t'' the corrected initial temperature of water in the boiler.*

In the preceding formulæ, the latent heat of steam has been taken at 1000°, the number generally used in this country; but after all the calculations had been made on this subject from the experiments by Messrs. Wilson and Kingsbury, and the results sent in to the Admiralty, Regnault's excellent memoir on the latent heat of steam was published. It became necessary, therefore, to use these new results in the future experiments. These, so far as they apply to the present inquiry, are reduced in the following Table:—

TABLE No. I.—*Showing the Specific and Latent Heat of Water and Steam.*

Air Thermometer Centigrade.	Mercurial Centigrade.	Number of Unities of Heat abandoned by one kilo. of water in descending from T to 0°.	Air Thermometer Fahrenheit.	Mercurial Fahrenheit.	Number of Unities of Heat contained in one pound of water at T°.	Mean Specific Heat of Water between 0° and T cent. or between 32° and T. Fahr.	Specific Heat of Water from T to T + d T.	Latent Heat of Steam saturated to the temperature T.	
								Centigrade.	Fahrenheit.
°	°		°	°					
0	...	0·000	32	...	32·000	...	1·0000	606·5	1091·7
10	...	10·002	50	...	50·003	1·0002	1·0005	599·5	1079·1
20	...	20·010	68	...	68·018	1·0005	1·0012	592·6	1066·7
30	...	30·026	86	...	86·046	1·0009	1·0020	585·7	1054·2
40	...	40·051	104	...	104·091	1·0013	1·0030	578·7	1041·6
50	50·2	50·087	122	122·36	122·156	1·0017	1·0042	571·6	1028·9
60	...	60·137	140	...	140·246	1·0023	1·0056	564·7	1016·4
70	...	70·210	158	...	158·381	1·0030	1·0072	557·6	1003·7
80	...	80·282	176	...	176·507	1·0035	1·0089	550·6	991·1
90	...	90·381	194	...	194·685	1·0042	1·0109	543·5	978·3
100	100·0	100·500	212	212·0	212·900	1·0050	1·0130	536·5	965·7
110	...	110·641	230	...	231·153	1·0058	1·0153	529·4	952·9
120	...	120·806	248	...	249·450	1·0067	1·0177	522·3	940·1
130	...	130·997	266	...	267·794	1·0076	1·0204	515·1	927·2
140	...	141·215	284	...	286·187	1·0087	1·0232	508·0	914·4
150	150·0	151·462	302	302·0	304·632	1·0097	1·0262	500·7	901·2
160	...	161·741	320	...	323·133	1·0109	1·0294	493·6	888·5
170	...	172·052	338	...	341·693	1·0121	1·0328	486·2	875·1
180	...	182·398	356	...	360·316	1·0133	1·0364	479·0	862·2
190	...	192·779	374	...	379·002	1·0146	1·0401	471·6	848·9
200	200·0	203·200	392	392·0	397·760	1·0160	1·0440	464·3	835·7
210	...	213·660	410	...	416·588	1·0174	1·0481	456·8	822·2
220	...	224·162	428	...	435·480	1·0189	1·0524	449·4	808·9
230	...	234·708	446	...	454·474	1·0204	1·0568	441·9	795·4

It also became desirable to introduce new corrections, which the progress of the inquiry showed to be needful. Thus, Mr. Phillips' careful experiments determined the alteration in the capacity of the boiler at different temperatures, and correction was in future made for this difference. The alteration in the capacity of the measuring tanks was also estimated, whenever the temperature differed 2° from that at which they were guaged. Another cause of error, for which allowance should be made, is any difference which may exist between the initial and final temperature at the beginning and close of the experiment. This difference being known by observation, the correction may be applied from the Table of Expansion of water in the boiler, given in the Appendix. Introducing these new corrections into the experiments for ascertaining the coefficient of the heating power of the wood, the following are the formulæ used by Mr. Phillips:—

$$\frac{(W + w - w')(l + t) + w t' + (w' - w) t''}{P l} = E.$$

In which W is the water let down from the tanks during the experiment.

w = The weight of water (as found by the Table of Expansion) found in the boilers at commencement of experiment.

w' = The weight of water in boiler at close of experiment.

l = Coefficient of the latent heat of steam.

t = Quantity of heat necessary to raise the water in tanks from its mean temperature to that at which it is evaporated.

t' = Quantity of heat necessary to raise the water in the boiler from the initial to the final temperature.

* A small correction must be also made for the combustible matter in the *residua* of combustion, such as the soot and carbonaceous matter in the ashes: to do this with great accuracy, a series of observations and analyses would have been required, the labour and expense of which would not have been warranted by the amount of correction necessary. It was, therefore, considered sufficient to proceed as follows, although the result is nothing more than a very rough approximation to the truth. For such an approximation, it will be admitted that the evaporative value of the coal depends on the ratio of the combustible to the incombustible matter, and that this ratio confers a similar evaporative value on the quantity of ashes, cinders, and soot, produced by the combustion; in other words, that if the combustible matter of the latter had been usefully applied in the production of steam, a similar effect would have been produced as if a corresponding quantity of coal had been burned. If, then, Q be the weight of coal containing the same quantity of combustible matter as the *residua* after its combustion in the furnace,

$$\frac{(l + 212 - t') w + (212 - t'') W - l e q}{(P - Q) l} = E,$$

the corrected co-efficient of evaporating power.

Let, then, w_1 = weight of ashes after the experiment. w_2 = weight of cinders after experiment. w_3 = weight of soot after experiment.

The weight of the cinders is taken after the clinkers are separated.

Let r_1, r_2, r_3 be the per centage of combustible matter in the ashes, cinders, and soot respectively.

Q the weight of coal containing the same weight of combustible matter.

r the per centage of combustible matter as found in the coal by analysis;

Then $r Q = r_1 W_1 + r_2 W_2 + r_3 w_3$

$$Q = \frac{r_1 W_1 + r_2 W_2 + r_3 w_3}{r}$$

t' = Quantity of heat necessary to raise water at the temperature of tanks to the final temperature of water in the boiler.

P = Weight of combustibles consumed during experiment.

E = The coefficient of the heating powers of wood.

But when the initial is lower than the final temperature, the formula becomes—$\frac{(W + w - w')\,l + Wt + wt' + (w' - w)\,t'''}{P\,l} = E.$

All the terms retaining their original value except the last, in which t'' is replaced by t''' (or the heat necessary to raise the final temperature to that at which the water was expanded), and must be regarded as having a negative value, while t' becomes positive. If, now, q is the weight of wood used in lighting the fire, the formulæ for estimating the evaporative power of the coal will be

$$\frac{(W - Eq + w - w')\,l + (W + w - w')\,t + wt' + (w' - w)\,t'}{P\,l} = E'$$

And

$$\frac{(W - Eq + w - w')\,t + Wt + wt' + (w' - w)\,t'''}{P\,l} = E'$$

As the experiments are strictly comparative, and under like conditions, the want of the other corrections, to which we have alluded above, will not be felt in examining the results; while their execution would have introduced a refinement into the experiments which never could be obtained in practice, and which, in fact, would be useless and unwarrantable, while, as previously remarked, the errors of observations in all such approximative experiments remain so large.

The only omitted correction which, in appearance, might be supposed necessary for practical purposes, is that for the hygroscopic condition of the fuel. Had wood been employed, this must have been done; but the hygroscopic nature of coal is very much less than that of wood. The latter contains one-fifth of its own weight of hygroscopic water; and the heat necessary for the evaporation of this quantity might be shown, by a simple calculation, to be nearly equal to 22 per cent. of the total heat obtained by the combustion of the wood. The hygroscopic water in coal is, however, very small, as will be seen by the following determinations of some of the Welsh specimens experimented upon:—

	Hygroscopic Water.		Hygroscopic Water.
Graigola Coal	1·06 per cent.	Myndd Newydd	0·67 per cent.
Anthracite	2·44 "	Pentrepoth	0·78 "
Old Castle	0·74 "	Pentrefelin	0·70 "
Ward's Fiery Vein	1·27 "		

Had we introduced corrections for these small quantities, practice would have been misled; because the coals will rarely reach a vessel in the dry state that they did in the present case, when they were packed in hogsheads and kept under cover.

It was found unnecessary to correct for any inflammable gases flying up the chimney, because the repeated analyses of the chimney gases proved them not to contain any combustible constituent; the only products ever found being carbonic acid, sulphurous acid, oxygen, and nitrogen. The quantity of free oxygen in the chimney varied from one-quarter to half of the oxygen, which combined with the fuel; in other words, nearly twice the quantity of air passes through the fire than that which is strictly necessary by theory.

LATE SPECIMENS OF GLYPHOGRAPHY.

The proposals of a Mr. Volkmar Ahner of Leipzig, respecting a discovery of his in glyphography, and intended for circulation amongst the artists of Germany, has lately fallen into our notice. He affirms that he has brought the art to such perfection that it may be advantageously employed in every case where drawings of any kind are to be published by the printing press. The principal reason why glyphography has not been hitherto employed in illustrating periodical works is, that the galvanic solution requires a longer time than can well be afforded in publications where quickness of production is a main point. Mr. Abner declares that he has removed the obstacle of delay, by discovering a means of transferring drawings of all kinds in a very short time upon *clichées;* but in order that artists may derive the full benefit of the process, it is necessary that they should make themselves practically acquainted with it; and Mr. Ahner proposes to dispose of his invention by way of subscription.

Another discovery which he offers to make public in the same way, and along with the other, is that of converting a drawing, executed upon the original glyphographic plate, into a hollow matrix, so that this can be used as a mould for the printing, casting, or galvanoplastizing of plates whereupon the glyphographic drawing appears in relief. In other words, he produces a mould, without an intervening model, which will serve for the multiplication of bas-reliefs. This process may also be applied to all purposes where pressure, moulding, or galvanoplastiziug is used to produce embossed ornaments. This alleged invention certainly appears rather extraordinary; and persons conversant with such matters will find it difficult to conceive how, without a previous form, and merely by a drawing, a hollow matrix can be produced, from which an optional number of bas-reliefs can be taken. The inventor, however, avers that he afforded a proof of the possibility of the thing to the Leipzig Polytechnic Society, at their session last December, and that the members were completely satisfied on that head.

Every one acquainted with the delay and expense of the old system will appreciate the importance of these discoveries. Glyphography will thus give the draughtsman the means of obtaining copies of his design without having recourse to any of the graphic arts. To artisans themselves it will be of immense importance, especially to those who produce embossed or hollow embellishments upon their work—such as metal-founders, silversmiths, saddlers, manufacturers of ornament in leather, papier machée, gutta percha, &c.

The notice of the invention, whence we have gleaned these particulars, was accompanied by two illustrative examples of Mr. Volkmar Ahner's works. The first is a landscape or garden scene, with figures dancing in the foreground; it exhibits, in a remarkable degree, the freedom of the artist's pencil, being totally devoid of that stiffness of drawing so generally to be found in glyphographs; still, the faces of the figures, and other delicate portions, are not finished up in the style of a good woodcut, the hard outline not being properly softened off, and too great an expanse of blank space is left in places where lines are required to give expression. We also observe the presence of a defect, against which the early wood engravers laboured for some time—that is, the heavy, harsh appearance of the boundary lines of the drawing. Just at the period of the elevation of wood engraving to the character of an art, when wood first gave promise of rivalling copper and steel, as a material whereon to adapt the artist's designs for multiplication to a thousand-fold extent, this formed one of the many objections brought against the modern system of surface printing.

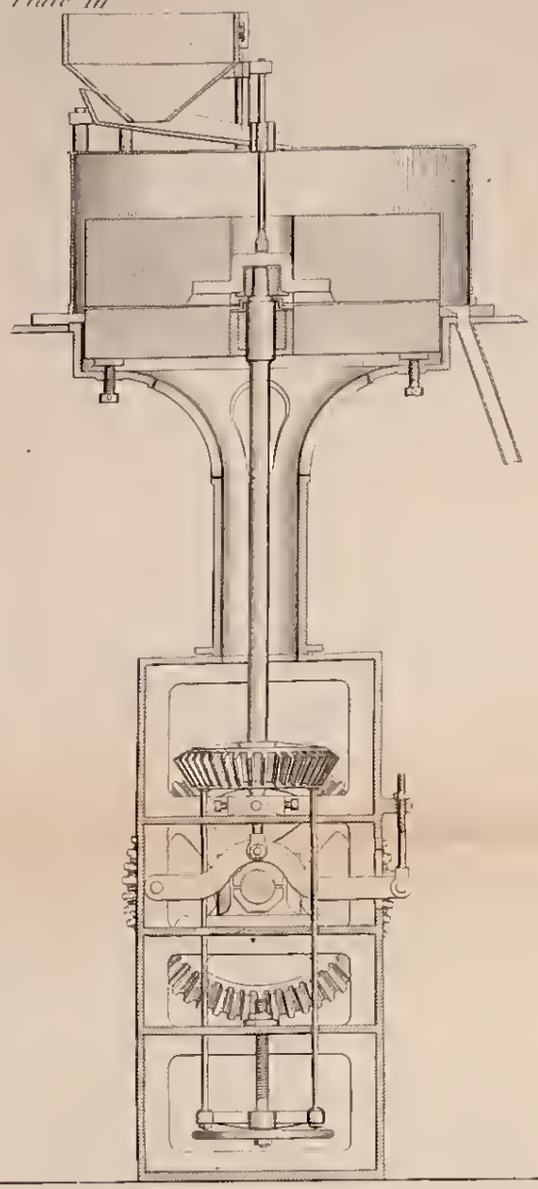
On examining a well-executed modern vignette on copper or steel, we find that the irregular edge of the design is beautifully softened off, and at its extremity completely disappears, and is lost in the unprinted ground of the sheet. It is easy to produce this effect from the metal plate, which prints in the intaglio manner, for any depth of shade may be attained simply by engraving in narrow or wide lines, or by cutting them more or less deep, so as to retain a greater or less supply of ink. In surface printing from wood the case is different, as, although broad or narrow lines may be employed at pleasure, yet, as it is the prominent surface which gives the impression, the result is that, in printing from a perfectly flat and level block, every line is equally distinct. To mitigate this evil, the system of "lowering" was adopted. This plan consists in the cutting or scraping away of the surface of the block at those parts where the print is intended to be light. In preparing the block for a vignette on this principle, the outline of the design is first lightly sketched out, and the engraver then lowers or scrapes away the surface at the edges of the drawing to the extent required, which may be from the thickness of a sheet of paper down to as far as one-sixteenth of an inch, or even more, according to the lightness intended, or to suit the different requirements of the hand and steam-press. It is this arrangement which gives to vignette cuts the beauty and delicacy of appearance which is found in the works of the best engravers of the present day. The same method is adopted when it is wished to give the effect of distance to any portion of a drawing, as the far off glimpse of a landscape, which may, perhaps, be placed in the centre of the block. Great care and skill are required to produce a proper effect in this latter case, as the part to be lowered must be very carefully managed, so as to avoid injuring the adjacent darker lines.

We cannot see why this principle may not be applied to glyphography; possibly there may be some practical difficulties in the way of its application to metal surfaces; if so, it is certain that wood engraving will always possess an immensely superior capability of pictorial effect. The second example, which is the same size as the first—about 6 inches by 4, is a cow feeding. With the exception of a perceptible stiffness in the drawing, this specimen is superior to the former one; the hairy coat of the animal is beautifully represented, and in particular the short, curling, woolly hair between the horns is accurately rendered. As a medium for representing large mechanical or architectural designs, such illustrations as are contained in our own Journal, for instance, we should deem the process peculiarly applicable, if practice does not reveal any corresponding drawbacks. The difficulties occasioned by the smallness of the wooden blocks, the warping and splitting, and general liability to injury in working, would be done away with, and great accuracy and evenness of lining would result. We shall probably hear further of the matter.

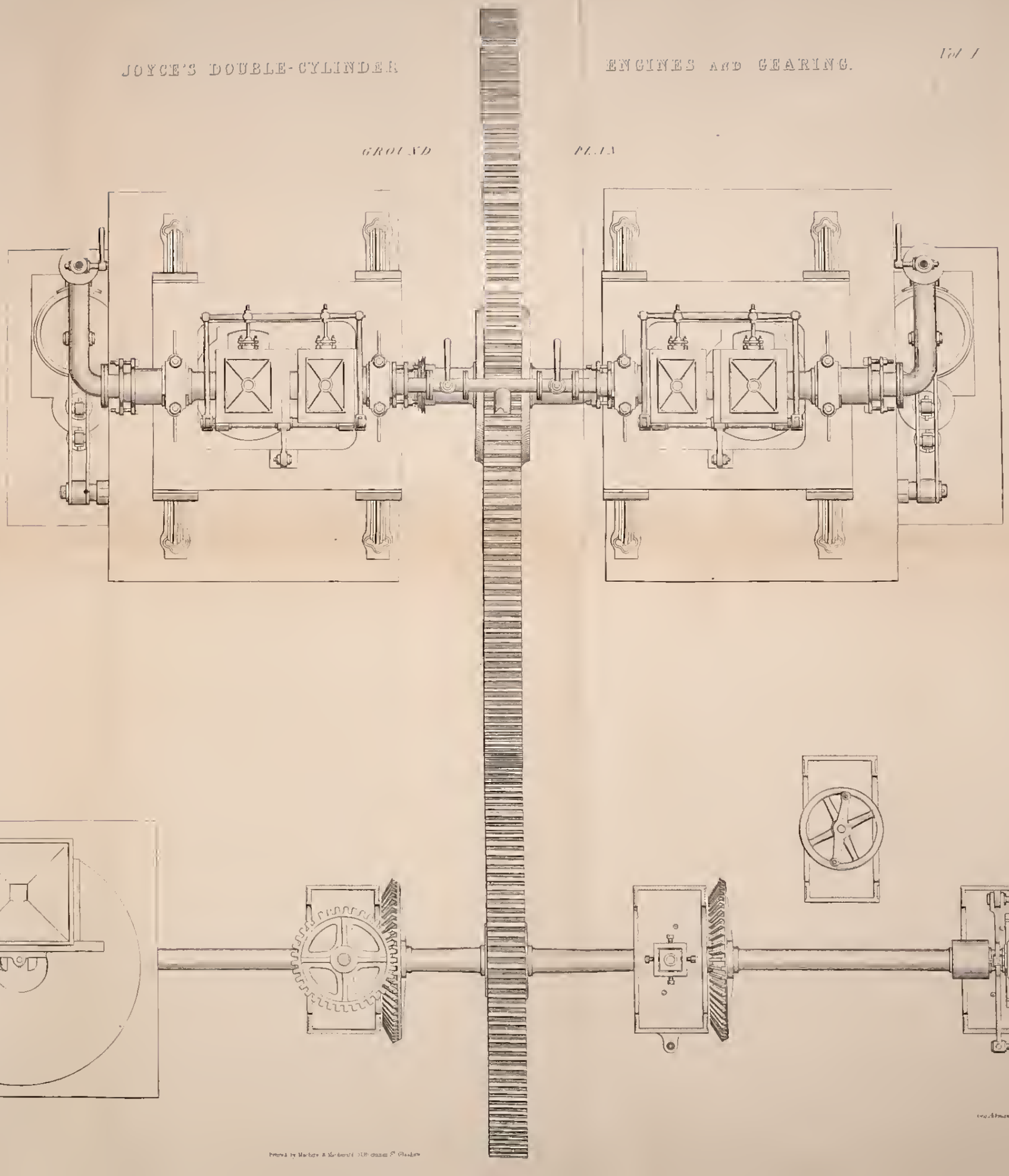
Plate III

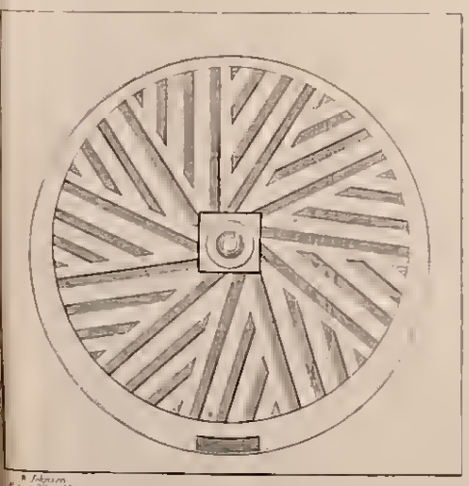
JOYCE'S DOUBLE-CYLINDER ENGINES AND GEARING.

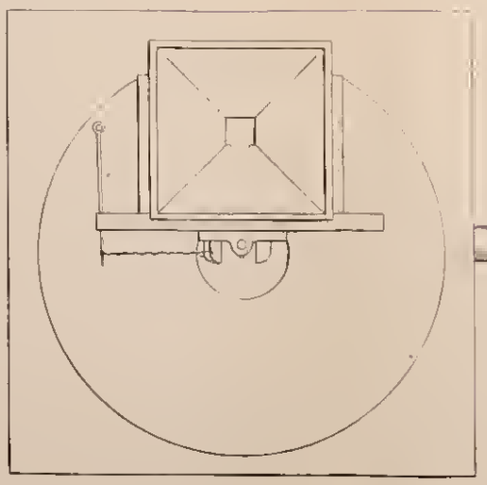
Pl. I



GROUND PLAN

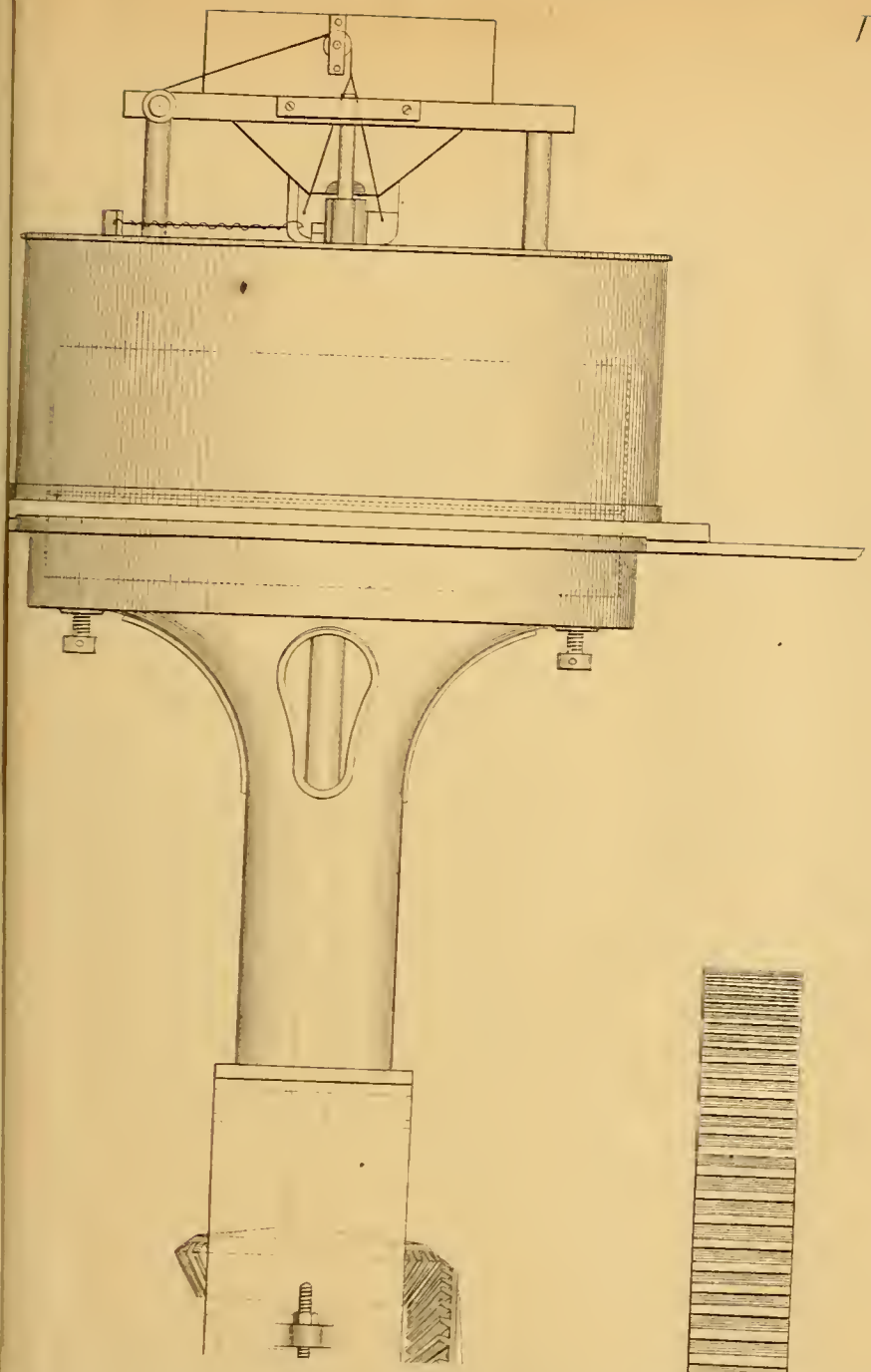


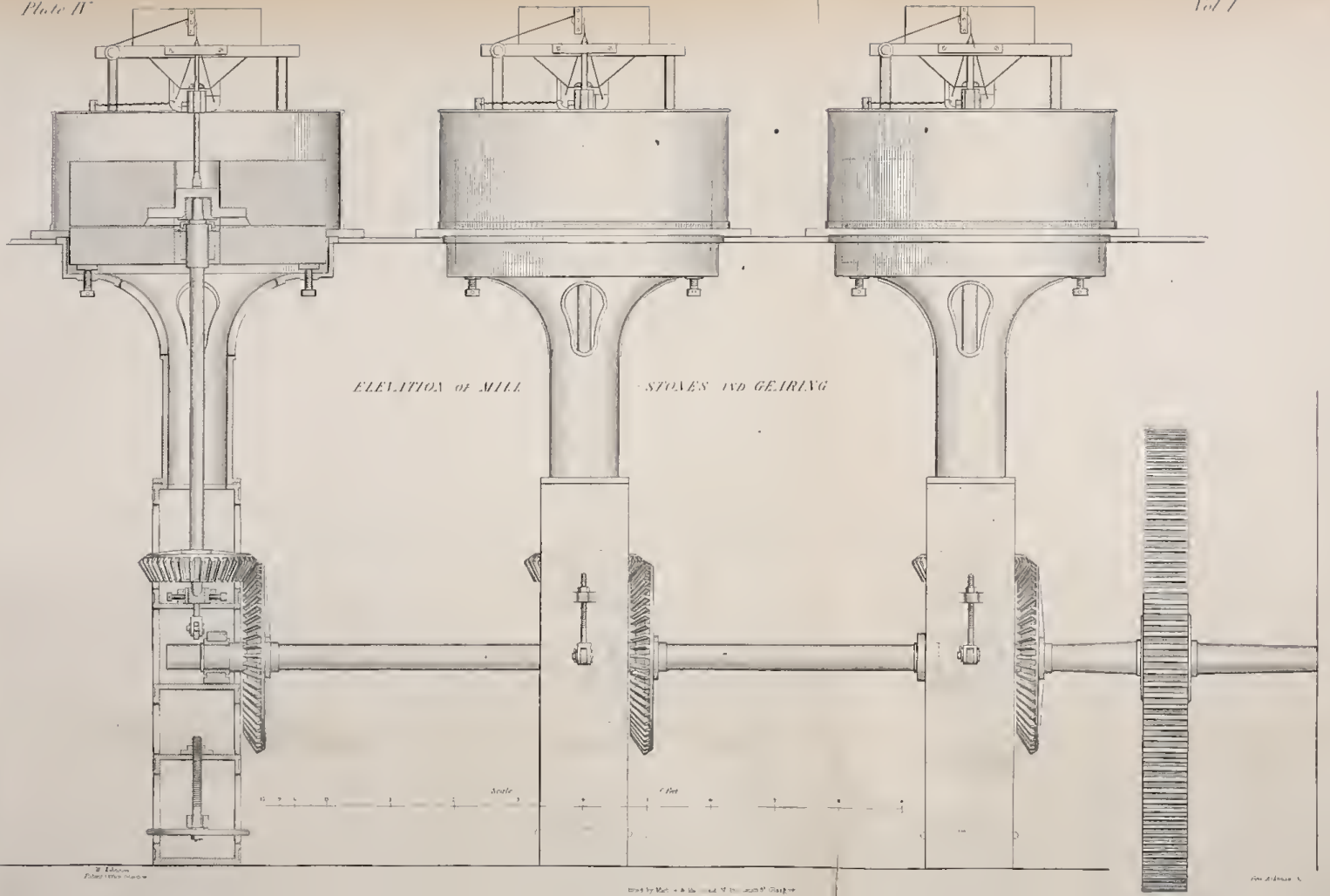




Printed by Hanhart & Ackermann, Lith. chemins St Claude

Vol. I.




ELEVATION OF MILL STONES AND GEARING
Scale
1 Foot

JOYCE'S DOUBLE CYLINDER PENDULOUS CONDENSING ENGINES AND MILL-WORK.

Illustrated by Plates 3 and 4.

In following ont the details of this example of machinery, we now preseut, in Plate 3, a complete ground-plan of the pair of engines corresponding to the two elevations given last month, in Plates 1 and 2, together with a portion of the gearing, stones, &c., which they are employed in working. The three several views, taken in combination, will enable the observer to ohtain a clear notion of tbe action of the steam, and the general working of the valve apparatus. The steam from the boiler is conveyed to the cylinders by the small pipe shown broken, directly above the main spur-wheel, on tbe crank-shaft. From this pipe, hranches proceed at right angles, to each cylinder, being bolted to short connecting-pipes passing into stuffing boxes formed in the bollow cylinder trunnions, the open ends of which pipes lead directly into tbe valve-chests of the small high-pressure cylinders. At the commencement of the working of the engines, the steam is conducted into tbe upper end of tbe high-pressnre cylinders. At the end of this stroke, both pistons being at the hottom of their respective cylinders, the two slide valves will bave taken up a reverse position, and the upper end of the high-pressure cylinders will exhaust the steam of their former stroke into the valve-chests of the larger or lower pressure-cylinders, the valves of which are then open into the lower ends of tbeir cylinders; whilst, at the same time, the lower end of the former cylinders will receive a fresh snpply of high-pressure steam from the boiler, through their own valve-ports. At the third stroke, the exhaust steam from the lower end of the high-pressnre cylinders will pass into the upper end of the large cyliuders, the exhaust from the lower end of the latter passing off hy the external hollow trunnions into the vertical condensing pipe shown leading down to the air-pnmp.

The varions tboronghfares for the steam may be made out from the several views. The main steam-way, by which the whole of the exhaust steam from the high-pressure cylinder passes into the valve-chest of the large cylinder, is represented in the sectioned elevation of Plate 1, where, also, is clearly shown tbe passage connecting the exbaust port of the large cylinder witb the condenser. In Plate 2, is given a side view of the long external port by which the low-pressure steam is passed to and from the lower end of the large cylinder; and in the grouud-plan, Plate 3, an end view of this port, and the corresponding one of the small cylinder, is ohtained. From the arrangement of the injection water and exhanst pipes, it will be ohserved that the condensation will he entirely effected in the large vertical copper pipe, which connects the exhaust trunnions of the cylinders with the circnlar cast-iron chambers surrounding the air-pumps. The injection-cocks are placed immediately above the npper ends of the condensing-pipes, and the water descends through them to the perforated cnds of the tubes, where it meets the effinent steam in a heavy shower. The engines are fitted with two air-pumps, worked hy cranks on the extremities of the main crank-shaft. The connecting-rods of these cranks are attached to vihrating levers, which are carried at one eud by fixed stnds, bolted to brackets cast on the lower surface of the foundation-plates of the engine. The contrary ends of tbese levers are linked directly to the bncket-rods of the air-pnmps, the parallelism of the rods being preserved by vertical guide-spindles, working npwards throngb guide-brackets on the foundation-plates. The same lever also serves to work the hot and cold water pnmps, whicb are both attached to the side of the air-pump.

The large central spnr-wheel is cast with a heavy rim, to act as a fly; it is 14 feet diameter, and works into a second wheel of 7 feet diameter, on the main horizontal shaft, driving six pairs of grinding-stones. The plan of tbe gearing of these stones, in Plate 3, exhibits six different views and sections of the apparatus. The end figure on the extreme left of the line of shafting represents the grooved grinding surface of the lower stone—the npper one being removed. The next figure is a complete plan of the hopper and cover of the grinding-stones as fitted for work. The tbird, or the one on the left of the second motion spur-wheel, is a horizontal section through the wrought-iron spindle and framing of the gearing, immediately above the pair of bevil-wheels. The apparatus of the fourth spindle, on the opposite side of the spur-wbeel, is represented by a section throngh the cast-iron framing, immediately below the bevil-wheel on the mill spindle, which is here removed so as to show the adjustable footstep of the spindle; the hand-wheel of the disengaging apparatus of the bevil-gearing is represented by the dotted circle, tbe disengaging side-rods being shown in section. The fiftb, or last view on the line of shafting, is a section of the framing immediately below the partition which carries the footstep of the mill spindle, showing the pillow-block or pedestal of the main horizontal sbaft, which is carried by a second partition of the framing. The same view also shows the wrought-iron cross adjusting-lever of the mill-spindle, which is hinged at one extremity to an eye cast on the inner side of the framing. The section of the framing of the sixtb pair of stones is taken below the third or lowest partition, which carries the nut of the screw-spindle of the disengagiug apparatus of the gearing; it is represented in the detached view, with a portiou of the main sbaft and the large bevil-wheel in dotted lines.

In Plate 4, is given a complete elevation of three pairs of stones in working order—one pair, with its containing framing, heing shown in vertical section, in a line with the main sbaft centre. A similar section of a pair of stones, taken at right angles to the line of the main shaft centre, is contained in Plate 3. The details of the stones, which are used for griuding bones, are mainly similar to those of the latest improved corn mills; the open rectangular cast-iron, containing the driving gearing, is bolted down to a stone foundation by four holding-down bolts. It sustains on its three partitions, the foot-step of the mill spindle, the pillow-block of the main shaft, and the nut, acting as the fulcrum of the disengaging apparatus of the bevil-gear. This frame is surmounted by an inverted hell-shaped casting termed the *Cone*, bolted down hy flanges on its lower end—its upper extremity being expanded, and terminating in a cylinder of a diameter slightly larger than the mill-stones—the lower of wbich rests within it—set screws heing provided for the accurate adjustment of the vertical and horizontal positions of the stone; suitable flanges are cast on the cylindrical portion of this cone, for attacbing it to the floor of the upper storey of the mill, which is sustained by it. Access to the interior of the eone is ohtained by four large openings cast in the sides of the expanding portion, which add materially to the appearance of the elegant curvature of this part. A light cylindrical case of thin sheet-iron is placed immediately above tbe cone, covering in the pair of stones, and acting as a confining receiver for the bone-dust in the process of grinding. The top of this cover supports a set of four standards, carrying the hopper and feediug apparatus for supplying the bones to be ground.

The mill-spindle is of turned wrought-iron; its upper extremity passes through tbe centre of the lower or fixed stone, and is attached to the upper one by a plate of cast-iron, with a central hollow and projecting arms, termed the *Ryne*. The extremity of the spindle is fitted into an eye on the lower end of a steadying spindle, which is forked so as to come down on each side of the *Ryne*, which tbus forms the connection hetweeu the stone and spindle, and permits of the free motion of the former in any direction. The lower stone carries a large square cast-iron block, into wbich is fitted the brass bush of the spindle, the top of the bearing being covered up to prevent contact with the bone dust. The stones, which are 4 feet diameter, are huilt up of French burr, cemented together by plaster of Paris, and bound round by iron hoops. In preparing tbe cutting surfaces of the stones, the lower one is first dressed up to a perfectly level surface, the upper one being slightly hollowed for a short distance round the central feeding apertures, for the purpose of admitting the material to he ground. The surface of each is then grooved, as represented in one of the figures of the ground plan, Plate 3.

Tbe faces of the stones are first divided into several equal parts, by lines drawn from the circumference to the centre; in the instance before us, tbese divisions are eleven in number. Chords are then drawu, connectiug the external houndary lines of each pair of divisions, as indicated by the dotted line; this chord will then be bisected by the central division line of the two compartments. From the intersection of these two lines, four equal parts are marked off, to the extremity of the chord, where it touches the circumference of tbe stone; and from these points are set off spaces equal to the widtb of the intended grooves, and througb these latter points lines are drawn parallel with the eleven radii, from the circumference, terminating in each radius line, thus forming the outlines of the grooves, which are cut vertically on oue side, and obliquely on the other, so as to produce sharp cutting edges. As each stone is cut in the same direction, with both faces upwards, it follows that when one is reversed, to bring them face to face, the sharp edge of the grooves will meet each other at an acute angle, and thus act most effectually in tbe reduction of the matter subjected to their action. The operation of cutting these grooves, which is a work of considerable labour, was, until lately, performed entirely hy hand-cutting with chisels. A simple instrument has heen lately introduced for this purpose, which adds materially to the accuracy of the work. It is nothing more thau a cutter attached to one end of a vibrating lever, attached to a moveable carriage, which may be set to traverse upon the surface of tbe stone at any required angle, an adjustable index being provided for securing exactitude in the widths of the different grooves.

The foot step of the spindle is of gun-metal, and is capable of accurate adjustment, botb horizontally and vertically. Its borizontal motion

is effected by the action of four set-screws, which pass through the square containing socket of the step, cast on the upper partition of the lower supporting frame; the step being slightly less in size than its containing socket, is at liberty to move to some extent in any horizontal direction. The vertical motion of the spindle, which is required for adjusting the grinding surfaces of the stones, is effected by a wrought-iron cross lever, hinged at one extremity to the interior of the frame, and, being bent upwards in the middle, to pass the main shaft, it projects through a slot in the opposite side of the frame, where it is jointed to the double eye of a screw adjusting-link, the upper end of which passes through a projection east on the frame, and is secured by a nut on the upper side. A short link is jointed to this lever, immediately beneath the centre of the spindle, and a hole being formed in the partition above, the link is passed through, and the foot-step rests upon it; in this manner the miller is enabled to vary the fineness of grinding by adjusting the nut of the end-supporting link of the lever.

The feeding apparatus consists simply of a receiving hopper, placed above, and near the circumference of the stone case, through the bottom aperture of which, the bones drop upon the inclined surface of a discharging guide or feeder, which is adjustable at any angle, so as to feed quicker or slower, by means of a cord passing upwards over a small fixed pulley attached to the front of the hopper. This feeder has attached to its highest end a small eye, working on the top of a vertical spindle carried by the top of the stone-case. On this spindle, as a centre, it has a horizontal reciprocatory motion, derived from a small cam on the small spindle passing through the centre of the upper stone; this cam works between the opposite sides of the opening in the end of the feeder, a slight spring attached to the stone-case and connected to the feeder by a string, being employed for assisting the movement.

The pinion on the mill spindle is fitted to slide vertically upon a feather, so as to permit of the motion of the spindle in adjusting the stones, without interfering with the true gearing of the wheels. This arrangement also answers for the disengaging of the pair of wheels, when the stones are to be stopped for repair, &c.

This is effected by means of a small hand wheel, represented at the bottom of the frame, as fitted to a screw spindle, the upper end of which works in a nut, carried by the lowest partition of the frame. A short cross-head, resting upon a shoulder on the lower end of the spindle, is fitted with two vertical side rods, carrying a cast-iron ring at their upper end. In this way, a few turns of the bottom hand-wheel will elevate the spindle pinion, so as to be out of gear with its driver.

On referring to the plan of the mill-stone in Plate 3, and the vertical section in the same sheet, it will be seen that the stone-case is placed in a position slightly excentric to the stones beneath it; this is done for the more ready delivery of the bone-dust, the discharging aperture being placed in the centre of the greatest excentricity of the case, the ground substance finds an easy escape. In addition to the six pairs of stones, figured in our plates, the engines are driving three sets of crushing rollers, and eight mixing machines, with the usual accompaniments of creepers and elevators. The indicated power of the engines doing this amount of work is 50 horses, although stated as of 40 nominal horse-power in our previous account. The whole machinery has been regularly at work for two years at the Bone Mills and Patent Manure Manufactory of Mr. Lawes at Deptford, and has never caused a single delay for repairs. This is the best character which we can give to the work, as it is, in every sense of the word, a practical one. The low rate of consumption of fuel is a satisfactory proof of the economy of the arrangement of the steam cylinders, and we are persuaded that the principle of the double cylinder, which owes much to the Messrs. Joyce for its introduction under the oscillatory form, will be hereafter extensively introduced where economy in expansion, combined with extreme regularity of motion, is a matter of consideration. This opinion is in a considerable degree strengthened by the recent applications of the system by Mr. M'Naught of this city, an account of whose performances will be found in our present pages.

GAS LIGHT REGULATORS.

We have before us an interesting Report by a Committee of the French Academy of Sciences, consisting of Messrs. Poncelet, Morin, and Payen, upon two Gas Regulators constructed by Messrs. Mutrel and Pauwels. The regulators have for their object the controlling of the pressure and supply of illuminative gas, according to the demand or consumption. When the lamps of a city, or even of a single manufactory, are first lighted up in an evening, we always find that, owing to the supply, the pressure is so great as to produce a long streaming flame, loaded with carbonaceous matter, and shedding a dim uncertain light, requiring the stop-cock to be partially closed, in order to reduce it to its true level. Compared with the amount of light given by the lamp under these circumstances, the expenditure of gas is very great, indeed, quite extravagant. When the lighting has become more general, the increased flow of gas causes a diminution of the pressure, the flame lowers perhaps to as great an extent as it was before elevated, and it becomes necessary to re-adjust the stop-cocks so as to give a full passage to the gas. The inverse effect results at a later period of the evening; as the lights are gradually extinguished, the flame again rises; thus two adjustments are necessary each evening; and, notwithstanding the greatest attention, very great and sudden changes in the intensity of the flame are continually taking place. Whenever an excess of pressure occurs, the flame is no longer provided with an excess of atmospheric air; but from the absence of a due supply of oxygen, the combustion is incomplete, and the carbonaceous particles thrown into the flame in excess, pass away unconsumed, and even a considerable portion of the gas escapes combustion. To this cause, together with the liberation of sulphurous combinations, we must assign, in a great measure, the tarnishing of gilding, &c. in our dwelling-houses.

In M. Mutrel's regulator, the governing power is obtained by the adoption of a bell-shaped vessel, or miniature gasometer, the elevation or depression of which, according to the varying pressure of the flow of gas, diminishes or enlarges the aperture for the supply. This vessel is attached to the shorter arm of an oscillating lever, the longer end of which sustains an adjustable weight. To this lever a connecting link, acting on the supply valve, is attached, and by means of the weight, the pressure may thus be altered or re-arranged at pleasure. In M. Pauwell's apparatus, the adjusting vessel acts upon a circular stopper, which is fitted to move within a conical tube. When the pressure of the gas rises, the stopper is pushed along the tube towards the narrow diameter, and when it falls, the reverse takes place. Both these regulators have been tested on a large scale at different theatres and railway stations, and a considerable economy in the consumption of gas has resulted.

Different regulators have come under our notice in this country, but we believe none of them are applied to any extent.

SULPHUR.

The following interesting facts relative to this body, form the substance of a lecture recently delivered at the Athenæum, in Manchester, by Mr. F. C. Calvert. We are indebted for the abstract to a Manchester paper:—

Sulphur exists very abundantly in nature, but it is principally collected in volcanic countries. A great portion of the sulphur employed in Europe is obtained from Sicily, to which country its extraction is so important, that, out of 2,000,000 inhabitants, about 20,000 are employed in it; and the amount received by Sicily for sulphur exported, amounts to about £366,000 per annum. The quantity imported into England a few years back was about 7,000 tons; but since the reduction of the duty from £15 to 10s. per ton, there has been so great an increase in the manufacture of sulphuric acid, that from 30,000 to 40,000 tons are now imported annually. Sulphur exists in nature not only in the mineral, but most abundantly in the vegetable kingdom also: without it, plants could not exist; for there is no plant in which albumen is not found, and to the existence of albumen, sulphur is an indispensable requisite. In the animal kingdom, too, sulphur exists in large quantities. In its preparation, sulphur undergoes two processes: being first purified in a most careless and wasteful manner in Sicily, impurities being allowed to remain ranging from 3 to 26 per cent., the general average being about 15 per cent.; it is afterwards purified in England, the process varying according as roll or flour sulphur is required. Flour sulphur is not, chemically speaking, as pure as the roll, as it is liable to contain sulphuric acid; and this fact, if not known, might lead to failure in certain operations. Sulphur is a bad conductor of heat, and also of electricity; and another curious property it possesses is, that, when heated in a crucible, it first becomes fluid, then thick like treacle; and, if still further heated, it becomes fluid again. If poured into water when in the second state, it becomes elastic, and it is thus rendered available for taking impressions of seals, &c.; but if it is allowed to cool, or to boil, it will then be brittle. Sulphur forms with oxygen seven chemical compounds, but only two possess any interest—sulphurous acid and sulphuric acid. One instance of the extensive use of sulphur is in the manufacture of gunpowder, which is composed of sulphur, 12½ parts; carbon, 12½; and saltpetre, 75—so that every time a 24-pounder is fired, for which a charge of 8 lb. of powder is used, 1 lb. of sulphur is employed. The application of sulphur in the arts is very extensive; and there is one very common application of it, of which the importance is not, perhaps, properly appre-

ciated: it is, that no chemist in Europe can supply, at a low price, any substance which can replace sulphur in the manufacture of matches. Sulphurous acid, one of the compounds of sulphur with oxygen, is much used in art. It is found to escape in torrents from the mouths of volcanoes; and it is generally believed that its inhalation caused the death of Pliny the elder, A.D. 79. It is found that this acid is the only material with which woollens and silks can be bleached, and its application to this purpose is very simple and extensive. Sulphurous acid is soluble in water, but this solution had no application until of late years. It is now, however, used for restoring colours; and the man by whom the discovery was first made, a Parisian, realised a splendid fortune by restoring the colours of cashmeres. There is a substance imported into England from the Cape of Good Hope, called jute, which had hitherto been considered of no use, from the supposed impossibility of bleaching its fibre; but this has lately been effected, and a white and silky appearance imparted to it; and it will no doubt be hereafter extensively employed as a substitute for hemp and flax, from the fact that it can be obtained at a much lower price. Sulphurous acid is the only thing by which this bleaching can be effected; for if placed in an alkaline liquor, jute is reduced into a soft pulpy state. By means of sulphurous acid, water can be frozen in a red hot crucible; and this led the lecturer to make some reference to a cause of boiler explosions. Many bodies possess the curious property of taking, under given circumstances, a spheroidal form, and, when in this state, they possess very different properties. Water in a red-hot crucible takes this spheroidal state; and it is remarkable, that the evaporation is then fifteen times slower than in its ordinary state; still more remarkable, that although the crucible is red-hot, the temperature of the water is only 205°, instead of 212°, at which water boils; and when the crucible is allowed to cool a little, the water suddenly passes off into steam. Supposing a man in charge of a boiler found that water had become short, and possibly the side or bottom plates red-hot, he lets in a small quantity of water; this immediately takes the spheroidal state; and on his letting in more water, the plates being cooled to the requisite temperature, the whole passes off into steam, and an explosion is the result. The other useful combination of sulphur with oxygen, sulphuric acid, also called oil of vitriol, has become of so much importance, that without it we should most undoubtedly be deficient of a great number of comforts which we now enjoy; in fact, its importance is such that, in the present day, we may judge no longer of the importance of a nation by the amount of gold which that nation possesses, but by the amount of sulphuric acid and iron it manufactures and employs; and if England stands as the first nation upon the earth, it is not from the extent of the surface of her land, but from the trade and business she carries on, and this she carries on by means of sulphuric acid and iron. The quantity of sulphuric acid manufactured in England at the present time is at least 50,000 tons annually. It exists abundantly in nature, but not in a pure state, and is chiefly found in the rivers of South America. Sulphuric acid is first mentioned in the ninth century: it was Basil Valentine who, in the fifteenth century, discovered the means of obtaining it by the calcination of green copperas; but it was only in the year 1746 that two Englishmen conceived the idea of extracting it from sulphur, by means of the large leaden chamber now used. 300 lb. of acid is obtained from 100 lb. of sulphur. The theory indicated 306 lb. as the quantity which should be produced; so that nearly the whole amount is obtained. There is a new process by which the acid can be obtained, and in which platinum is the chief agent; and as this process is much more simple than the present, it will, no doubt, soon become prevalent. Sulphuric acid can also be produced in a solid state; the advantage of which will be evident to those who know the difficulty of obtaining vessels for its exportation in a fluid state, as well as the danger which often attend its removal from the manufactory to different warehouses. A singular property of sulphuric acid is its power of drawing or attracting from the atmosphere fifteen times its own weight of water; a fact which should induce those using the acid to be careful that the earboys are well corked. When by this attraction of the water the specific gravity of the acid is reduced below 1·24, it becomes unfit for many purposes, and, among others, it will not dissolve indigo. Another curious property of the sulphuric acid is, that when exposed to the air, it becomes black; but this may be remedied by boiling the acid, and thus causing it to lose the water it has absorbed. Persons employing sulphuric acid cannot be too cautious, as on coming in contact with chloride of potash, turpentine, or other substances, a fierce combustion instantly follows. The lecturer concluded by describing the process of reproducing prints, writing, or engravings, on paper, or even on copper, steel, or other metals, in which process sulphuric acid is the principal agent—remarking on the advantage which will thus accrue to the engraver, who will be enabled to transfer his subject, if a copy, immediately to the plate, and thus to execute his work with facility and exactitude.

M'NAUGHT'S DOUBLE-CYLINDER STEAM-ENGINE.

We have lately inspected the practical results of the application of this modification of Woolf's engine, introduced some time back by Mr. W. M'Naught, engineer, of this city. The arrangement, as many of our readers are aware, is the combination of a high and low pressure cylinder, placed respectively on opposite sides of the main centre of the engine-beam, the exhaust steam from the high-pressure cylinder being re-applied expansively in the low-pressure one. The primary idea of the inventor was to supply a cheap means of providing auxiliary power for over-burdened engines, in place of the entire renewal of the whole. This he effected simply by the addition of a high-pressure cylinder, the piston-rod of which he connected to the beam at the eye originally formed to correspond with that of the air-pump. Such is the arrangement adapted to the engine driving the cotton works of Messrs. Bartholomew at Barrowfield, which is the earliest example of the kind. In this case, the original power of the engine was 136 indicated horses, the cylinder being 45 inches diameter; stroke 7 feet; pressure of steam 6½ lbs. The amount of auxiliary power proposed to be added was 80 horses; and to accomplish this, a high-pressure cylinder of 30 inches diameter, and 3 feet 6 inch stroke was added; the eye of the piston-rod end being directly attached to the parallel motion link of the pump-rod, midway between the main centre and the connecting-rod cross-head. In the original state of the engine, the supply of steam was obtained from a set of four waggon-boilers, 25 feet long, and 6 feet 6 inches wide, and 8 feet 6 inches deep, without any internal flue. These have now been replaced by six cylindrical boilers, 25 feet long, and 4 feet 6 inches diameter, with hemispherical ends, but having no internal flue. The steam, of 40 lbs. pressure, is conducted directly into the auxiliary cylinder, whence it is exhausted at each stroke into the low-pressure cylinder, the cubical contents of which latter is four times as great as that of the former. The action of the high and low-pressure pistons being in opposite directions, the objectionable straining of the main centre of the beam, so common in single cylinder engines, is almost entirely removed, no concussion being perceptible, although the speed of working is increased from 18 or 19 to 25 strokes per minute. The economy of the plan as regards consumption of fuel, amounts to 35 per cent. less fuel for the power exerted.

The plan has since been adopted, to a considerable extent, by manufacturers in Glasgow and Paisley. One of the latest examples is that of Messrs. Johnstone and Galbraith of Oakbank, near this city. The engine is a double one, with low-pressure cylinders of 34 and 38 inches diameter respectively; stroke 5 feet. The two high-pressure cylinders are attached in a manner exactly similar to that of the Barrowfield engine; they are each 28 inches diameter, and 2 feet 6 inches stroke, working into the low-pressure cylinders of 34 and 38 inches, and 5 feet stroke. The amount of work performed by these engines is as follows:—

Self-acting mules, spinning from 10s to 80s, averaging 30s—11,924 spindles; coupled or double-decked hand-mules, spinning from 70s to 80s—5,232 spindles; and preparation, including the whole of the necessary gearing, for 30,000 spindles.

Previous to the introduction of the double-cylinder principle, the works were driven by four low-pressure beam-engines of the following dimensions:

One with a 42 inch cylinder and 6 feet stroke, working to 65 horse-power; two coupled engines, of 34 and 38 inch cylinders, and 5 feet stroke; and a single portable engine of 25 inch cylinder and 3 feet stroke—the whole being supplied with steam by eight cylindrical boilers, 30 feet long, and 5 feet 6 inches diameter. The machinery driven by the small portable engine stands thus:—

Hand-mules spinning 60s—2,660 spindles; throstles, spinning from 18s to 24s—4,548; revolutions of spindles—4,200 per minute.

In consequence of the additional power obtained by the adoption of Mr. M'Naught's system of double-cylinders, the large single 42 inch cylinder engine is now entirely dispensed with, and the whole works are put in motion by the three smaller engines, and 7½ per cent. more work is turned off.

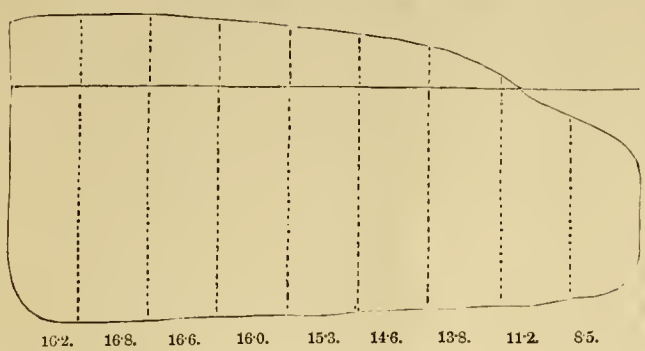
The consumption of fuel under the former arrangements amounted to 130 tons per week of sixty-two working hours. The present consumption averages 82 tons in the same time, being a saving of 35 per cent.; and although the speed has been increased to 29 strokes per minute, the working, we find, is much steadier than before. The present working pressure and cylinder action of the engines, as compared with the former system, are represented in the annexed indicator diagrams.

The first, which is on a scale of 10ths, is from one of the coupled engines previous to its alteration; the average combined pressure of the steam and atmosphere is 14·3 lbs., the cut-off being at about ¾ths of the stroke. It shows the engine to be in good working order, equal to the ordinary results of low pressure engines.

The second figure is on a scale of 20ths; it is taken from the high-pressure cylinder of one of the coupled engines, and shows an average pressure of 29·82 lbs.

Fig. 1.

24-inch Low-pressure Cylinder previous to Alteration.

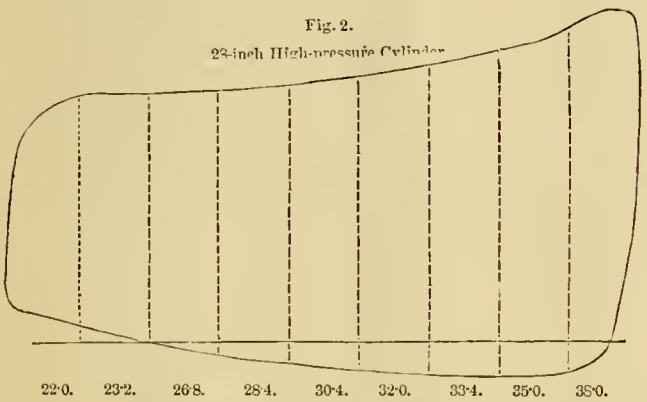


16·2. 16·8. 16·6. 16·0. 15·3. 14·6. 13·8. 11·2. 8·5.

Average effect on Piston, 14·3 lbs.

Fig. 2.

24-inch High-pressure Cylinder.

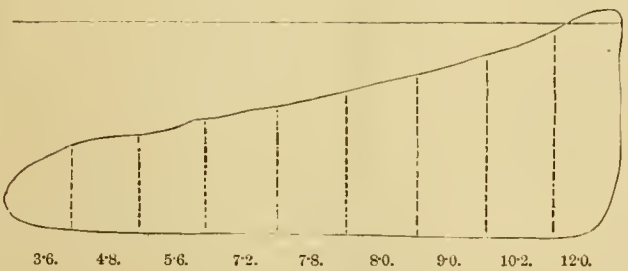


22·0. 23·2. 26·8. 28·4. 30·4. 32·0. 33·4. 35·0. 38·0.

Average effect on Piston, 29·82 lbs.

Fig. 3.

34-inch Expansion Low-Pressure Cylinder.



3·6. 4·8. 5·6. 7·2. 7·8. 8·0. 9·0. 10·2. 12·0.

Average effect on Piston, 7·52 lbs.

The third figure is taken from the low-pressure cylinder, as at present working with the exhaust steam of the high-pressure cylinder; it is on a scale of 10ths, and exhibits an average pressure of 7·52 lbs. These diagrams shew that when the low-pressure cylinder is working below the atmospheric pressure, a partial vacuum is obtained in the high-pressure one. The relative capacities of the two cylinders are as 1 to 4, but Mr. M'Naught intends in future, we believe, to arrange them in the ratio of 1 to 3, as thereby a larger useful effect may be obtained without the employment of excessive high pressure. The saving in fuel is the more evident when we refer to the first figure, and see the good state of working of the valves previous to the alteration. Another point connected with the consumption of fuel is also to be taken into consideration; that is, the supply of steam required for heating the dressing cylinders, pipes, and other apparatus of the works; the steam required for these purposes, having no connection with the working of the engines, could have no share in the economy of the new arrangement, the resultant saving is therefore less in proportion than it would otherwise have been, had the whole of the generated steam been employed in giving motion to the engines.

On a late visit which we paid to Messrs. Johnstone and Galbraith's extensive works, we found the double cylinder engine working perfectly smooth, although the rate of speed was much higher than that of ordinary engines of a similar size. The high-pressure cylinders stand upon short cast-iron pillars, carried by cross beams running along below the floor of the engine-house. The exhaust pipe, conducting the steam from these cylinders to the larger ones, is carried beneath the iron floor, and, with the exception of the additional cylinders, the whole presents an appearance little different from an ordinary single beam engine.

THE PROGRESS OF SCIENTIFIC DISCOVERY IN THE SEVENTEENTH CENTURY.

The second volume of Cosmos consists of two parts; the first of which is devoted to a consideration of the impression which the image received by the external senses, produces on the feelings and on the poetic and imaginative faculties of mankind. Humboldt here undertakes to trace the sources of that animated contemplation which enhances a genuine enjoyment of nature, and discovers the particular causes which, through the medium of the imagination, have powerfully promoted, especially in modern times, a predilection for the study of nature and for the undertaking of voyages and travels. In the second and larger part he sketches the gradual acquaintance of man with the phenomena of nature; in other words, he gives a concise history of physical science. The whole of this portion is full of interest to the lover of knowledge, and is written with great power. To follow the author through the whole is manifestly beyond the space at our command, but we think that the chapter on the progress of scientific discovery in the seventeenth century, taking the invention of the telescope as an epoch, may be of interest to our readers in a compressed shape.—

The history of the inventions of the telescope and the microscope has been much obscured by the confusion between those instruments, but a certain spectacle-maker at Middelburg, by name Hans Lippershey, seems to have the best title of being ranked the inventor of the former instrument, in 1608. It is however a singular fact, that Huyghens, who was born about 25 years after the supposed invention, was unable to say with certainty to whom the honour belonged. When the intelligence of an invention for seeing things at a distance, having been made in Holland, reached Venice, it came to the ears of Galileo, who, struck with its importance, began to work the matter over in his own mind, and soon unravelled the mystery. Without further instruction, he made a telescope of his own at Padua, with which he examined the moon's disk. This instrument magnified no more than four times in linear dimensions, but afterwards he procured one that had a power of thirty-two. He then proceeded to examine the milky way, and some of the fixed stars; the four satellites of Jupiter were discovered on the 7th January, 1610, a memorable epoch in the history of astronomy. The Copernican hypothesis was thus confirmed and extended, for here was seen a picture, in little, of the great system of which it was a part. A further confirmation was the discovery of the phases of Venus, which followed. In November, 1610, Galileo had found that Saturn consisted of more parts than one, but it was not until 1684, that the external portion was seen to be divided into two concentric rings.

John Fabricius, of East Friesland, first observed the spots on the sun's disk, and communicated his discovery to the world in June, 1611. Galileo, independently, made the same discovery, and thus the rotation of the great luminary of our planetary system was proved: a fact which Kepler, indeed, had conjectured before any spots had been noticed. The desire to investigate the heavens with the newly found instrument, was much stimulated by the sudden appearance and extinction, within the space of thirty-two years, of three stars, surpassing in brightness those of the first magnitude. About the same time several comets were visible to the naked eye, and these remarkable events naturally led philosophers to speculate upon the nature of celestial bodies and their motions. It was supposed that a cosmical vapour filled the regions of space, that all the heavenly bodies were formed out of it, and that the new stars had been condensed from it, and then resolved into it again. Comets also were regarded as having a rectilinear motion, and formed out of this celestial air.

The discoveries, in quick succession, of the satellites of Jupiter, the complicated structure of Saturn, the solar spots, and the crescent form of Venus, wonderfully enlarged our knowledge of the regions of space, and concentrated the attention of scientific men of the time on astronomy. The truth of the Copernican system was firmly established in the minds of thinking persons, but at the court of Rome it was deemed so fraught with error and danger to religion, that, in 1616, it was expressly prohibited, and sixteen years subsequently the Inquisition obliged Galileo to recant with his tongue the opinions which no force could expel from his mind. Meantime the splendid genius of Kepler worked out mathematically the three great laws which have immortalised his name.

Wendelinus, in 1626, determined the diminution of the obliquity of the ecliptic, and ascertained the sun's parallax. In 1631, Gassendi observed the transit of Mercury across the sun's disk, and succeeded in measuring the diameter of the same planet; and eight years afterwards the transit of Venus was in like manner observed by two English astronomers. In 1646, Fontana observed Jupiter's belts.

In passing to the second half of the seventeenth century, the first great discovery that meets us is that of a satellite of Saturn, by Huygheus, who had improved the construction of the telescope and increased its power. There was a prejudice amongst the astronomers of the period, that the number of secondary planets, or satellites, could not exceed that of the primary planets; and hence Huyghens did not seek any more of Saturn's attendants. The rest were discovered at wide intervals, and it was not until 1789 that the last of them was detected by Herschel, assisted by his colossal telescope. One these satellites moves with such rapidity, that it performs a revolution round the principal planet in less than one of our days. The Zodiacal light was then discovered—a luminous appearance best seen at the equinoxes, the true nature of which is still wrapped in obscurity. It has the shape of a broad pyramidal body of light, which begins to be visible as soon as the twilight disappears. Near the horizon, where it is broadest, it is very bright; and the light gradually decreases in intensity as the appearance narrows.

The spots of luminous cloud, denominated nebulæ, which have recently received much attention, have attracted observation in all ages. At the commencement of the sixteenth century, the Spanish and Portuguese sailors were struck with the two Magellanic clouds which revolve round the south pole, one being the "white ox" of the Persian astronomer, Abdurrahman Sofi, in the middle of the tenth century. Galileo regarded nebulæ as remote clusters of stars shining like the milky way, with massed light; an opinion which, after having been abandoned for that which looked upon these phenomena as cosmical matter in different states of condensation, has been again revived, from observations made by the gigantic Rosse telescope, an instrument which has already given to man new views of nature.

Whilst Galileo and Kepler enlarged our knowledge of the celestial spaces at the commencement of the seventeenth century, and Newton and Leibnitz advanced our acquaintance with pure mathematics towards its close—we must not forget that there were persons engaged in investigating many physical problems in other departments of science which occupy the attention at the present day. Huyghens was occupied with the double refraction of light in Iceland spar, and he discovered, in 1678, that kind of polarization to which his name has been attached. A century elapsed before the researches, thus commenced, were vigorously prosecuted by others, amongst whom Arago, Fresnel, and Brewster, are the most eminent. Arago's polariscope shows us a world of wonders: a ray of light emitted from a body at an inealculable distance, tells us, by means of this instrument, whether it is reflected or refracted, whether it emanates from a solid, a fluid, or a gaseous body, and measures also the degree of its intensity. The seventeenth century is not without indications, though they are faint ones, of a knowledge of the phenomenon of *interferences;* but it was not until these times that their causal conditions were discovered, and the clear recognition of the laws according to which rays of unpolarised light, proceeding from one and the same source, but with a different length of path, destroy each other and produce darkness. Newton's experimental researches on optics must be placed in this century, though this great work did not appear until 1704.

An important work on electric and magnetic forces, William Gilbert's "Physiologia Nova de Magneto," was published as early as 1600, in which work much of our present knowledge was anticipated by conjecture. He looked upon magnetism and electricity, as emanations of one fundamental force pervading all matter; and he regarded the earth itself as a great magnet. Investigations on the magnetism of the earth are proceeding in our times with great activity; and the British Government has most laudably given directions to scientific and hydrographic expeditions, to make observations with accuracy and frequency, so that in a short time we may expect a body of facts collected from all quarters, such as will enable us to construct a magnetic map of the world—an object that has long been desired. With reference to this subject, the name of Edmund Halley must be mentioned with deep respect. In 1698, he prevailed upon the government to equip a naval expedition for the purpose of testing his theory of magnetic poles, and the periodical movement of magnetic curves. He performed three voyages in the Atlantic ocean, in a ship of which he had the command; and, from the observations he made, he constructed a chart, whereon the points at which he found the same amount of declination, were connected by curved lines. This undertaking must be deemed an epoch in the history of terrestrial magnetism. We cannot discover from Gilbert's writings, that he had noticed the phenomenon of repulsion, as well as that of attraction; it was Otto Guericke who is the first recorded observer of the former, and he it was who heard the first sound, and saw the first light, in artificially created electricity. Newton noticed, in 1675, in one of his experiments, the process of charging a plate of glass with electricity. The identity of friction, electricity, and lightning, had been repeatedly conjectured before Franklin's time; but it was reserved for that philosopher to prove the fact. This branch of science, like those of optics and magnetism, has had periods of slow developement; but since Franklin, much attention has been directed to it, and at this very day, one of the acutest of living experimentalists is employing himself upon it.

Since all alterations that take place in terrestrial matter are connected with modifications of heat, light, and electricity, and since the phenomena of temperature operating by expansion are most palpable to sense, the invention of thermometric instruments marks an important epoch in the advance of physical knowledge. The thermoscopes of Galileo were dependent concurrently on changes of temperature, and on variations in the pressure of the air. As early as 1641, observations of temperature were made five times a day at many stations with spirit thermometers, such as we now have, and the temperature of mineral springs was also examined, and gave rise to speculations respecting the heat of the globe. A year after Galileo's death, Torricelli constructed the barometer, and that instrument was soon employed in measuring the altitude of objects. Its subsequent use in extending the bounds of physical geography and meteorology are well known. Before the close of the seventeenth century, the foundations of the theory of the atmospheric currents were laid. Lord Bacon considered the direction of winds in connection with temperature and aqueous precipitations. Hooke, acting on juster views respecting the movement of the earth, recognised the influence of its rotation, and the existence of upper and lower currents of warm and cold air passing from the equator to the poles, and returning from the poles to the equator. In the next century, Halley took up Hooke's views and explained them more circumstantially. The same period is not wanting in attempts to investigate the moisture of the atmosphere in its connection with variations of temperature, and with the directions of the wind. Rude hygrometers were used, but the results of observations were of little value, in consequence of the want of fixed wet and dry points.

Pneumatic chemistry had its rise in the seventeenth century; but although many important phenomena were correctly apprehended, yet their connection was not truly seen, and the investigations of such men as Hooke and Boyle were incumbered by the old notion of the simplicity of the constitution of atmospheric air; so that the processes of combustion, oxidation, and respiration, were wholly misunderstood. Van Helmont first used the word gas; he conceived that the clouds are vapours which become gas by cold, and the influence of the heavenly bodies. Jean Rey discovered that the increase of weight during the calcination of lead was owing to air uniting itself to the metallic calx, but he does not appear to have been aware that this calx itself was a combination of metal and air; and we may conclude from his language, that the union he referred to, was, in his view, merely a mechanical addition of air to the calx. The notion of essentially distinct gases never became clear at that time, and the difference between atmospheric air, and other gases, was attributed to the admixture of certain vapours. It was not until the latter half of the succeeding century, that the distinctness of oxygen, carbonic acid, and hydrogen gases were shown, and their properties examined. The investigation of the chemical composition of the atmosphere, by an accurate determination of the quantitative relations of its constituent parts, is one of the great points in modern meteorology.

To Nicolaus Steno, a Danish anatomist in the service of the Duke of Tuscany, belongs the merit of throwing out the earliest conjectures as to the super-position of rocks; and a work of his, published in 1669, contains some wonderfully accurate views of geology. He speaks of rocks hardened before the existence of plants and animals, and sedimentary strata alternating with each other, and covering those previously mentioned. He says, that deposited strata were originally horizontal, and that they have become inclined from the outbreak of subterranean matter, causing mountains and valleys. He distinguishes between marine and fresh water petrefaction. In 1678, Martin Lister, an English physician, observed, that each kind of rock is characterised by its own fossils. Many theories respecting the structure of the earth's crust, sprung up afterwards; but from the want of a scientific mineralogy, all that relates to the crystalline and massive eruptive rocks and thin transformations, remained unstudied. Earthquakes, thermal springs, and volcanic eruptions, were ascribed to merely local causes, instead of being regarded as the effects of the reaction of the plant against its external crust.

The mathematical figure of the earth was theoretically sketched at the end of the seventeenth century; but the numerical ratio of the polar and equatorial diameters was not accurately assigned. Newton concluded, from the earth's rotation, that it was compressed at the poles, and he endeavoured to calculate the amount of compression upon the assumption

of homogeneity of mass. But the true figure was not ascertained until degrees were measured under the equator, near the north pole, and in the temperate zones of both hemispheres. The existence of the compression is evidence of the greatest and most ancient geognostical event —the primitive condition of the fluidity of the planet, and its gradual solidification into the present shape.

The discovery, by Newton, of the force whereby the universe is kept in orderly motion, was nearly contemporaneous with that of the infinitesimal calculus, which has since led to new mathematical discoveries. This improvement in the means of analytical research has operated most beneficially in that mutual fructification of ideas, which is no less important than their abundant production; and thus new regions of immeasurable extent in the physics of the universe, both in its terrestrial and celestial spheres, have been opened to us. "The creation of new organs, or instruments of observation, augments the intellectual, and often also, the physical power of man. More rapid than light, the electric current now carries thought and will to the remotest distance. Forces, whose silent operation in elementary nature, as well as in the delicate cells of organic tissues, still escapes the cognizance of our senses, will one day become known to us; and called into the service of man, and awakened by him to a higher degree of activity, will be included in a series of indefinite extent, through the medium of which, the subjection of the different domains of nature, and the understanding of the universe, as a whole, are brought continually nearer."

SERIES OF EXPERIMENTS RELATIVE TO THE FAN BLAST.

By W. Buckle, Esq., Soho Works, Birmingham.

[The following article contains the substance of a communication originally made by the author to the rising Institution of Mechanical Engineers at Birmingham. As a sound practician, Mr. Buckle has long been deservedly distinguished in connection with the celebrated works of Messrs. Boulton & Watt of Soho; we therefore feel a more than ordinary amount of pleasure in finding him coming forward to give the profession the benefit of his ample experience.

From the endless variety of fans in use among engineers and founders, and the contradictory results often obtained, it may be presumed that the philosophy of blowing air has hardly yet found a place in the engineer's catechism; or, if it has, that he has not conned its pages. We have met with every possible incongruity in the shape of fans—eccentric vanes, curved vanes, and numberless monstrosities of cases have borne the test of experiment, without leading to anything like settled opinions on the theory of the matter. The production before us is well calculated for a text-book, to which the practical man may judiciously refer, as he will find the subject discussed in all its bearings, and the deductions from the writer's experiences lucidly set forth and developed to suit the exigencies of the work-shop.

Mr. Buckle has since extended his researches on the subject, and next month we may be able still further to assist in the dissemination of the principles of the system thus attained to by actual trial.—Ed. P. M. J.]

The fan has become an indispensable machine in smithies and foundries; it abridges time and labour, and is otherwise a great improvement over the old system of bellows. The uniform stream of the former admits of no comparison with the puffy blasts of the latter. By means of the fan, the smith can heat his work with precision, he can vary at discretion the size of his nozzle tweyre, without deteriorating the density of his blast. He can conveniently heat one piece of work while shaping another.

In a well-regulated smithy, the main pipe from the fan is furnished with an air chest and with nozzle pipes, varying from one to three inches in diameter. The pressure of the blast is made to range from four to five ounces per square inch. A nozzle pipe of $1\frac{5}{8}$ inch diameter is found a suitable size for general engine forcings.

The position of the fan in its chest, or the one preferred and generally made use of, is an eccentric position. The continually increasing winding passage between the tips of the vanes and the chest, serves to receive the air from every point of its circumference, and forms, as it were, a general accumulating stream of air to the exit pipe. The particles of air having passed the inlet opening, and entering on the heel of the blade, would retain the same circular path were it not for the centrifugal force of the air due to its weight and velocity, impelling them forward towards the tips of the vanes, and this continued action is going on, particle following particle, till they are ultimately thrown against the fan chest, and are impelled forward to the exit pipe. It is by this centrifugal action that the air becomes impelled and accumulated into one general stream. But, as will be presently shown, there is a certain velocity of the tips of the fan which best suits this action.

An ordinary eccentrically placed fan, 4 feet diameter—the blades 10 inches wide and 14 inches long—and making 870 revolutions per minute, will supply air at a density of 4 ounces per square inch, to 40 tweyeres, each being $1\frac{5}{8}$ inches diameter, without any falling off in density. The experiments herein detailed were made with a fan 3 feet $10\frac{13}{16}$ inches diameter, the width of the vanes being $10\frac{3}{4}$ and the length 14 inches; the eccentricity of the fan $1\frac{7}{8}$ inches, with reference to the fan case, the number of vanes being 5, and placed at an angle of 6° to the plane of the diameter; the inlet openings on the sides of the fan chest $17\frac{1}{2}$ inches diameter, the outlet opening 12 inches square; the space between the tips of the blades and the chest increasing from $\frac{3}{8}$ inch on the exit pipe to $3\frac{1}{2}$ at the bottom, in a line perpendicular with the centre. To the blast pipe leading to the tweyeres a slide valve was attached, by means of which the area of the discharge was accurately adjusted to suit the required density.

The guage to indicate the density of the air, was a glass graduated tube, primed with water, it being more sensitive and having a greater range than the mercurial one.

1	2	3	4	5	6	7	8	9	10	11	12
No. of Experiments.	Number of Revolutions of Fan per Minute.	Velocity of the Tips of Vanes in Feet per Second.	Density of Air in Ounces per square Inch.	Height of Mercury in Inches equivalent to the Density.	Height of Column of Air equivalent to the Density of Air in Feet.	Area of Discharge Pipe in square Inches.	Indicated Horse Power.	Theoretical Velocity of Air in Feet per Second.*	9-10ths of Theoretical Velocity of Air in Feet per Second.*	Theoretical Quantity of Air discharged in cubic Feet per Second.	Density of Air calculated by Laws of Centrifugal Force per square Inch.
No.											
1	1160	236·8	9·4	1·175	1093·10	closed.	9·60	264·4	237·96	no dis.	9·3
2	1081·66	220·8	7·9	·987	918·20	"	7·54	242·4	217·8	"	7·8
3	1000·	204·16	6·9	·862	801·91	"	6·68	226·5	203·85	"	6·8
4	907·5	185·28	5·6	·7	651·21	"	5·36	204·1	183·69	"	5·5
5	840·	171·5	4·5	·562	522·8	"	3·82	182·9	164·61	"	4·4
6	705·8	144·10	3·5	·437	406·5	"	2·214	161·2	145·08	"	3·4
Fan discharging Air at a Density of SEVEN Ounces per square Inch.											
7	1086·6	221·8	7	·875	814·01	37·5	13·31	228·24	205·4	59·4	6·92
8	1063·3	217·00	7	·875	"	38·125	11·02	228·24	205·4	60·4	6·92
Fan discharging Air at a Density of SIX Ounces per square Inch.											
9	1086·6	221·8	6	·750	697·72	48·75	13·81	211·3	190·17	71·5	5·93
10	1045·	213·3	6	·750	"	53·125	12·54	211·3	190·17	77·91	5·93
11	941·6	192·2	6	·750	"	24·375	6·43	211·3	190·17	35·71	5·93
Fan discharging Air at a Density of FIVE Ounces per square Inch.											
12	1086·6	221·8	5	·625	581·43	60·	14·26	192·9	173·61	80·37	5 nearly
13	1035·83	211·48	5	·625	"	65·	13·05	192·9	173·61	87·	5 "
14	950·	193·9	5	·625	"	52·5	8·75	192·9	173·61	70·32	5 "
15	855·	174·5	5	·625	"	22·5	4·53	192·9	173·61	30·	5 "
Fan discharging Air at a Density of FOUR Ounces per square inch.											
16	1086·6	221·8	4	·5	465·1	69·	14·19	172·5	155·25	82·65	3·95
17	1035·8	211·48	4	·5	"	75·	13·33	172·5	155·25	89·84	3·95
18	966·66	196·68	4	·5	"	65·62	9·53	172·5	155·25	78·6	3·95
19	870·	177·62	4	·5	"	78·125	11.32	172·5	155·25	93·58	3·95
20	760·	155·11	4	·5	"	33·125	3·3	172·5	155·25	38·98	3·95
Fan discharging Air at a Density of THREE Ounces per square inch.											
21	983·33	200·7	3	·375	348·86	82·68	10·15	150·	135·	86·	2·94
22	855·	174·5	3	·375	"	102·72	10·61	150·	135·	117·1	2·94
23	773·33	157·8	3	·375	"	80·63	7·56	150·	135·	93·33	2·94
24	659·16	134·5	3	·375	"	56·25	2·98	150·	135·	58·5	2·94
Fan discharging Air at a density from TWO to ONE Ounce per square inch.											
25	786·66	160·5	2	·250	232·5	151·6	9·1	122·	109·8	128·4	1·98
26	676·6	138·15	2	·250	"	124·125	5·89	122·	109·8	107·24	1·98
27	760·	155·1	1	·125	116.28	264·9	9·38	86·26	77·63	158·6	·983
28	676·6	138·15	1	·125	"	264·9	7·27	86·26	77·63	158·6	·983
Fan discharging Air at various Densities.											
29	1166·66	238·1	8·75	1·093	1016·81	13·75	11·94	254·75	229·27	24·32	8·62
30	1160·	236·8	8·5	1·062	987·97	16.25	11·9	251·2	226·08	28·34	8·40
31	1140·	232·7	8·	1·	930·3	22·5	12·36	244·	219·6	38·12	7·91
32	855·	174·5	2·4	·3	279·09	126·3	10·61	133·6	120·24	117·1	2·36

* These figures in the first six experiments are merely inserted to show the Velocity due to its respective Density of Air; also to allow a comparison being made with the real Velocity of the Tips of the Vanes, without having recourse to calculations.

Note.—In calculating the cubic quantity of Air discharged per second (as shown in column 11), no allowance has been made for the friction of the Air against the sides of the pipes and apertures.

These experiments were made with a view to ascertain what density of air could be obtained, with the vanes moving at given velocities, the outlet pipe being closed, and also at given velocities, with the outlet open; but its area varied at discretion. And further, to ascertain the horse-power required to drive the fan under the varied conditions.

The horse-power was ascertained by an indicator, the friction of engine and gearing being deducted in each experiment. With reference to the term *theoretical velocity*, as used in the table, it may be necessary to observe, that thereby is meant the velocity which a body would acquire in falling the height of a homogeneous column of air equivalent to the required density. Having given the necessary preliminary explanations of the blast above that of the atmosphere, we come to the experiments as recorded in the table.

The first column is the number of experiments.

The second is the number of revolutions of the fan per minute.

The third is the velocity of the tips of the vanes in feet per second.

The fourth is the density of the air in ounces per square inch, as indicated by the guage.

The fifth is the height of mercury in inches equivalent to the density.

The sixth is the height of a column of air equivalent to the density in feet.

The seventh is the area of the discharge pipe in inches.

The eighth is the indicated horse-power.

The ninth is the theoretical velocity of air in feet per second.

The tenth is $\frac{9}{10}$ of the theoretical velocity of air in feet per second.

The eleventh is the theoretical quantity of air discharged in cubic feet per second.

The twelfth is the centrifugal force of air per square inch, taken from theoretical velocity.

By this paper it is intended to be shown that there are certain velocities with which the tips of the vanes of a fan should move according to the required density of air, and that there are certain laws which govern these velocities.

First.—Water is 827 times heavier than air, mercury is 13·5 heavier than water; consequently mercury is 11164 heavier than air. A column of mercury, one inch in height, would therefore balance a column of air 11164 inches or 930·3 feet in height.

Let A be a column of mercury equal in height to any given density, and let B represent 930·3, and C 64*; then $\sqrt{(A \times B \times C)} = V$, or the velocity that a body would acquire in falling the height of a column of air equivalent to the density.

Second.—The centrifugal force of air coincides with the results obtained by the laws of falling bodies, that is when the velocity is the same as the velocity which a body will acquire in falling the height of a homogeneous column of air equivalent to any given density, as will be shown by our table (column 12). Here we have taken the velocity as obtained from the laws of falling bodies (as in column 9) to obtain the centrifugal force or density of air. To do this, apply the following general rule.

Having given the velocity of the air, and the diameter of the fan, to ascertain the centrifugal force—

Rule.—Divide the velocity by 4·01, and again divide the square of the quotient by the diameter of the fan. This last quotient multiplied by the weight of a cubic foot of air, at 60° Fahrenheit, is equal to the force in ounces per square foot, which, divided by 144, is equal to the density of air per square inch.

Or, substituting the following formula, we have $D = \frac{N V}{} \times \cdot 000034$. Where D is the density of the air in ounces per square inch, and N the number of revolutions of fan per minute, and V the velocity of the tips of the fan in feet per second.

Let us now compare the results of the foregoing table. To do this, we will first take the velocity of the tips of vanes per second, and the power necessary to drive the fan. We will first take Nos. 1, 2, 3, 4, 5, and 6; and we shall find, by inspecting the table, that the corresponding velocities to these numbers are 236·8, 220·8, 202·1, 185·2, 171·5, and 144·1, and the corresponding densities of air per square inch are 9·4, 7·9, 6·9, 5·6, 4·5, and 3·5 ounces. The fan, it must be understood, is discharging no air, the velocity of the fan is merely keeping the air at a certain density or pressure per square inch. Under these circumstances, it requires a certain velocity of the tips of the fan to maintain a certain density of air, but not in a direct ratio.

The laws which govern the velocity of the tips of the fan appears from these experiments to be $\frac{9}{10}$ of the velocity a body would acquire in falling the height of a homogeneous column of air equivalent to the density. This we have called the theoretical velocity, and by comparing Nos. 1, 2, 3, 4, 5, and 6 experiments as above—that is, by comparing the velocity of the tips of the fan per second with $\frac{9}{10}$ of the theoretical velocity—we shall find them to agree tolerably near. Thus, if the velocity of the tips of the fan per second be represented by 1·, then $\frac{9}{10}$ of the theoretical velocity will be represented by

1·004 in No. 1 experiment.
·986 ... 2 ...
1·008 ... 3 ...
·990 ... 4 ...
·960 ... 5 ...
1·0007 ... 6 ...

The mean 1·008

But we shall not only find that the $\frac{9}{10}$ of theoretical velocity governs the fan when it is not discharging air, but that the theoretical velocity governs it also when the outlet pipe is open; that is, that the maximum effect of the fan is when the vanes move from the theoretical velocity to $\frac{9}{10}$ of that velocity due to the density of the air, that the greatest quantity of air is discharged by the fan under these conditions with the least expenditure of power. To illustrate this more fully, let us refer to the table of experiments, and for our example we will take No. 9, 10, and 11; here the density in each is six ounces. In No. 10 the velocity of the tips of the vanes is 213·3 feet per second, while the theoretical velocity is 211 feet per second, being nearly the same. The quantity of air discharged is 77·9 cubic feet per second, and the power employed in this case amounts to 12·5 horses.

We take now No. 11 experiment. Here the velocity of the tips of the fan is 192· feet per second, and $\frac{9}{10}$ of the theoretical velocity 190 feet per second. Now these two experiments are in proportion to each other nearly, viz., in No. 11 the quantity of air discharged amounts to 35·7 cubic feet per second, and takes 6·4 horse power, while No. 10 discharges 77·9 cubic feet per second, and takes 12·5 horse power. Thus the discharge of air is nearly 2 to 1, and the horse-power employed in the same proportion.

We now take No. 9 experiment; here the velocity of the tips of the fan is 221 feet per second, being 10 feet per second more than the theoretical velocity; the cubic feet discharged per second being 71·5, and the power 13·8 horses. Now, if we compare this with No. 10 experiment, we shall find that the velocity is 10 feet per second more, and the cubic feet discharged 6 less, and the horse-power 1·3 more.

In the following examples we shall call the theoretical velocity per second unity, beginning with No. 15. In this example we shall also call the quantity of air discharged in cubic feet per second, unity, and also the horse-power. The density of the air in the four following experiments being 5 ounces per square inch.

	Theoretical Velocity.	Velocity of Tips of Fans.	Quantity discharged.	Horse-power.
No. 15	1	·906	1·	1·
" 14	1	1·007	2·34	1·93
" 13	1	1·098	2·9	2·9
" 12	1	1·150	2·67	3·16

In the five following experiments having a density of four ounces per square inch.

	Theoretical Velocity.	Velocity of Tips of Fan.	Quantity discharged.	Horse-power.
No. 20	1	·900	1·	1·
" 19	1	1·029	2·4	3·42
" 18	1	1·133	2·02	3· nearly
" 17	1	1·225	2·30	4·
" 16	1	1·280	2·12	4·27

In the three following experiments the density 6 ounces per square inch.

	Theoretical Velocity.	Velocity of Tips of Fan.	Quantity discharged.	Horse-power.
No. 11	1	·913	1·	1·
" 10	1	1·009	2·18	2· nearly
" 9	1	1·050	2·	2·15

The four following experiments density 3 ounces per square inch.

	Theoretical Velocity.	Velocity of Tips of Fan.	Quantity discharged.	Horse-power.
No. 24	1	.900	1.	1.
" 23	1	1.050	1.59	2.53
" 22	1	1.160	2.	3.56
" 21	1	1.338	1.47	3.40

To give a further illustration of this part of our subject, we will take No. 7, 9, 12, and 16 experiments. Here the velocity of the tips of the fan is the same which we shall denote unity. The correspouding densities

* The space which a gravitating body will pass through in one second is 16 1-12th feet; but by the principle of accelerating forces, the velocity of a falling body in any given time is equal to twice the space through which it has passed in that time, or the velocity is equal to the square root of the number obtained by multiplying *sixty-four* by the height in feet.

are 7, 6, 5, and 4 ounces, we shall call the highest unity, also the cubic feet discharged per second, and the horse-power.

	Velocity of Tips of Fans	Density of Air.	Theoretical Velocity.	Quantity of Air Discharged.	Horse power.
No.	7 ... 1	1.	1.028	1.	1.
"	9 .. 1	.857	.950	1.203	1.03
"	12 .. 1	.714	.869	1.35	1.06
"	16 ... 1	.571	.777	1.40	1.11

Nearly all the preceding examples justify our conclusion, that the greatest results are obtained when the theoretical velocity and the tips of the vanes are nearly equal. It carries its own conviction that if we increase the velocity of the tips of the vanes, and only double the cubic quantity of air delivered, that it must take more than double the expenditure of power, the density of air remaining the same.

We shall now give examples of the *data* dictated by our table of experiments. And first, having given the density of air per square inch, to determine the velocity of the tips of the vanes per second; also the horse-power requisite to drive the fan under these circumstances, the fan not discharging air, but its velocity merely keeping the air at a certain density.

Let D denote the density of the air in ounces per square inch, and A a column of mercury equivalent in height to that density. Then by the laws of falling bodies $\sqrt{(A \times 930.3 \times 64)} = V$ the velocity acquired by a body falling through a column of air of the corresponding density.

Then $\frac{38 \times D}{16} = P$ the number of pounds acting on the vanes and $\frac{2}{10}$ of V. $\times$ 60 P.

$\frac{\qquad\qquad}{33000}$ = H. P. or horse power required.

The constant number 38 is obtained by the following formula.

$\frac{H\ P \times 33000}{\frac{2}{10} \text{ of } V \times 60} = P$ Then $\frac{P \times 16}{D} = 38$

EXAMPLE.

Let D = 9.4 ounces per square inch, and A = 1.175 inches of mercury, to determine the velocity of the tips of the vanes per second, and also the horse power.

Then $\sqrt{(930.3 \times 64 \times 1.175)} = 264.4$, the theoretical velocity, $\frac{2}{10}$ of which is = 237.96 = V, or velocity of tips of vanes per second. Now

$\frac{38 \times 9.4}{16} = 22.32 = P$, or pounds acting on the vanes of fans. Then

$\frac{237.96 \times 60 + 22.32}{33000} = 9.6$ the horse power required.

Having given the velocity of the air in feet per second (or as it has been termed, the theoretical velocity) to determine the density of the air in accordance with the laws of centrifugal force.

Let the velocity be 264.4 feet per second, and the diameter of the fan 3.9 feet. Then by former rules we have

$\frac{264.4}{4.01} = 66.2$ and $\frac{66.2^2}{3.9} = 11169$ and $\frac{11169 \times 1.209}{144} = 9.3$ ounces

density, the answer required.

Or by the second rule, take the velocity of the fan in feet per second, multiplied by the number of revolutions of the fan per minute, the product multiplied by .000034 = the density required.

To determine the horse-power necessary to drive the fan when discharging air, the velocity of the tips of the vanes not to exceed $\frac{2}{10}$ of the theoretical velocity, having given the density of air required, also the cubic feet.

Here we must remark, that according to our table of experiments, when the tips of the vanes are to move at $\frac{2}{10}$ of the theoretical velocity, not more than 220 pounds of air are discharged per minute; but this is without any diminution in the density.

First, find the horse-power, as directed in former examples, when the fan is not discharging air.

Then multiply $\frac{1}{30}$ part of the weight of air to be discharged by the fan per minute in pounds by $\frac{2}{10}$ of the theoretical velocity, and *divide* by 33000. The quotient will give the horse-power necessary to discharge this quantity of air, which *add* to the horse-power necessary to drive the fan when not *discharging air*, for the answer required.

EXAMPLE.

Let D be the density of air required = 4 ounces A, a column of mercury equal to the density = .5 and W = the weight of air to be discharged = 220 pounds per minute, and V $\frac{2}{10}$ the velocity of fan in feet per minute.

$\frac{38 \times 4}{16} = 9.5 = P =$ the ponnds acting on the vane.

Then by former rule $V = \frac{9315.0 \times 9.5}{33000} = 2.67$ horse-power necessary to drive the fan without efflux.

Now a cubic foot of common air at 60° Fahrenheit weighs 1.209 ounces, therefore a cubic foot of the given density will be equal to 1.511 ounces, and $\frac{220 \times 16}{1.511} = 2330$ feet = the cubic quantity of air discharged per minute. And

$\frac{220}{60} = \frac{3.66 \times 9315.0}{33000} = 1.0$ horse-power necessary to discharge the given weight of air, and 1.0 + 2.67 = 3.67 = the total horse-power required.

When the velocity of the tips of the vanes is equal to the theoretical velocity, then we proceed as in the last examples, only we take $\frac{1}{30}$ instead of $\frac{1}{60}$ (as in former examples) of the weight of air discharged, which is added to the horse-power requisite to drive the fan when no efflux takes place.

We should here again remark that when the fan is moving at this velocity, it is capable of discharging 480 pounds of air per minute without any falling off in density.

In a recent set of experiments the inlet openings in the sides of the fan chest were contracted from 17½, the original diameter, to 12 and 6 inches diameter, when we obtained the following results.

First, that the power expended with the opening contracted to 12 inches diameter, was as 2½ to 1 compared with the opening of 17½ inches diameter; the velocity of the fan being nearly the same, as also the quantity and density of air delivered.

Second, that the power expended with the opening contracted to 6 inches diameter, was as 2½ to 1 compared with the opening of 17½ inches diameter; the velocity of the fan being nearly the same, and also the area of the efflux pipe, but the density of the air decreased one-fourth.

These experiments show that the inlet openings must be made of sufficient size, that the air may have a free and uninterrupted action in its passage to the blades of the fan, for if we impede this action we do so at the expense of power.

REFORM OF THE PATENT LAWS.

In the midst of the great movement of general reform which has been gradually increasing and extending in late years, that weighty incubus upon the inventor's talents, the patent law, has retained its position in the statute-book in all the glory of its expense and abuses. We need hardly enlarge upon the fact of the immense drawback to enterprising invention which its provisions involve, nor explain how an ancient code, patched up from time to time, is unfitted for the scientific transactions of the present day. Few of our readers who have looked to government for protection in matters of invention, will venture to disagree with us on the oppressive working of this accumulation of acts, the reformation of which we are advocating. We present below the particulars of a petition drawn up by Captain H. N. S. Shrapnel, and presented to Parliament, on the 30th of March last, by Mr. Brotherton. Captain Shrapnel has, for years back, given his attention to mechanical improvement, and possesses a considerable amount of experience on the subject before us. It will be seen that the petition embraces modifications in the direct cost, the mode of payment, and the proceedings to be adopted in cases of piracy; and its suggestions are, upon the whole, well calculated for the removal of the evil complained of. It states, "That the present payment and legal demands for her majesty's royal letters patent for the United Kingdom of Great Britain and Ireland, is not only an obstacle to national improvements, but is productive of great injustice to humble talent.

"That the law of patents, as it now stands, is not competent to give that protection from piracy which it professes to do.

"That the enormous expenses attending a patent utterly precludes the majority of your petitioners' scientific and talented brethren from availing themselves of the opportunity of securing to themselves the benefit of their labours, thereby (and which is too often the case) the intellectual property of humble talented men is taken advantage of by their more fortunate neighbours.

"That the inventive genius of the United Kingdom surpasses the whole

world. both as to the ratio of numher as well as talent. That thousands of nseful inventions now lie dormant and hidden in eonsequenee of the great exaetions and expenditnre neeessary to proteetion belonging to those who are willing, yet unahle, to avail themselves of the said protection. That payment for patents is attended with great risk, amounting in itself to speculation, and as sueh should be liberally treated with. That a patent is supposed to be granted to guarantee a patentee the benefits arising from his invention; hut, notwithstanding the enormous sums paid for sueh security to a majority of individuals, it amounts to no seeurity at all, inasmueh as the patentee has to hear all the endless expenses of prosecuting for piracy or infringement, and, if he unfortunately has not the means to proseente, the whole seeurity of a patent is overpowered.

"With the greatest respect for the talents and wisdom of your honourahle house, your petitioners humbly propose that a patent for England be redueed to five pounds, for Seotland five pounds, and for Ireland five pounds, annnal payments, thereby giving the patentee an opportunity to improve or discontinne any part of his invention. Seeondly, your petitioners humhly pray that your honourable house will render further proteetion and seeurity to patentees, by adopting erown proseeution for wilful infringements or piraey, instead of patentees heing obliged to submit to piracy for want of means to prosecute, and whieh misfortune reuders their patent property open to mutilation and ultimate loss of seeurity. Your petitioners further showeth, that the minimnm calculation is that ten patents wonld he seeured on the reduced scale, to one on the present seale, whieh, considering a patent extends to fourteen years, would more than triple the amount of revenne for patents.

Your petitioners will not now trouble your honourable house with statistical details relating to the nnmber of patents annually seeured, and the great advantages attending a reduetion in the priee of pateuts, hut yonr petitioners humbly pray your honourable house will be pleased to eonsider the great importance of sueh reduetions and alterations in the law of patents hereinbefore set forth, not only as a national boon to seience and humble talent, bnt as a means to eonsiderably increase the revenue for patents, or any other amount of reduetion or alterations your honourahle house may in your wisdom thiuk advisable for the benefit of the pnblie serviee, and the interests of those eoneerned."

The petition has appended to it tweuty-two signatures of patentees and others indireetly interested in the movement.

RECENT PATENT.

COCHRAN'S IMPROVEMENTS IN PRINTING WARPS.

The main feature of this patent fnrnishes ns with perhaps the best example we could have seleeted as illnstrative of the *inventive applications* of the present age, to which we referred at page 2 of our last Part. The inventor, Mr. Coehran of High Street, Paisley, has ehosen for the snhject of this new application, the jaequard maehine of Lyons, which has latterly undergone so many nseful modifieations. Could old Claud Jacquard look around him upon our present operations, he would doubtless feel delight and astonishment that his shawl-ornamenting prineiple should he employed in printing yarns in Paisley, and punching iron-plates in Wales. Yet such is the ease, and both adaptations have shown themselves to be perfeetly sueeessful. The principle of the process whieh the present improvements involve, is that, in plaee of weaving various coloured threads by the jaeqnard system, the jaequard is itself employed to print the required design upon the whole warp, or a series of warps together; whieh is then woven in an ordinary plain loom. The appearance of the printed warp, previons to weaving, is very remarkable; as, in order to allow of the exeessive taking np of the length of the yarn in weaving, eaeh portion of the design is elongated correspondingly, the face of the warp presenting a distorted, and eertainly very distant, resemblanee to the beantifnl details brought to light on its subsequent application to the loom. The title of Mr. Coehran's patent, sets forth that it contains "certain improvements in printing warps of earpets, velvets, or other textile materials; parts of whieh improvements are applicable to the production of coloured patterns or designs on woven fabries, or other plane snrfaces."

The invention relates to certain arrangements of maehinery or apparatns in connection with a jaequard machine as applied for the purposes of weaving—or a modification thereof, or with a simple and lashes, as employed in harness-weaving, or other apparatus capable of working or producing patterns, whereby coloured patterns may be impressed upon yarns made np into warps or webs for the manufacture of earpeting and other like fabries—with greater facility and eeonomy than by the ordiuary processes hitherto in use for the purpose. The ehief heads of the inveution are as follows:—

1st. The eolour apparatus for eontaining the different eolours to be applied to the material to be printed.

2d. The maehinery or apparatus for immersing the yarn of warps or webs into the different eolours, and also for imprinting the eolours upon eloth or other close-textured materials.

3d. The arrangement and "reading in" of the pattern on the jaequard maehine, or in the simple and lashes, or other apparatus eapable of prodneing the pattern.

4th. The arrangemeut of parts eouneeting the immersing or imprintiug apparatus, with the machinery employed to work the pattern.

From the very great length of this specification, and the numerous elaborate drawings conneeted with it, we are unable to report it in full, but the sueeeeding deseription will be sufficiently explanatory for the praetieal man. The maehine employed by Mr. Coehran for printing yarns, consists mainly of a strong upright frame of four pillars, arranged two on eaeh side of the apparatus, whieh is about 8 feet in width. Between each pair, and passing aeross the whole width of the framing, a transverse impressing beam of east-iron is arranged to slide. This beam is suspended, at intervals, along its leugth, by ehains passing over suitable pulleys, earried by an overhead shaft on the top of the pillars, and is eapable of being elevated or depressed by a small ehain-pulley, working on a stnd-shaft near the bottom of the maehine, and fitted with a wineh-handle; immediately beneath this beam, and resting upon supports attaehed to the main pillar, is the range of colour-troughs. Fig. 1 represents a plan; and fig. 2, a vertieal section of one of the series of cases

Fig. 1.

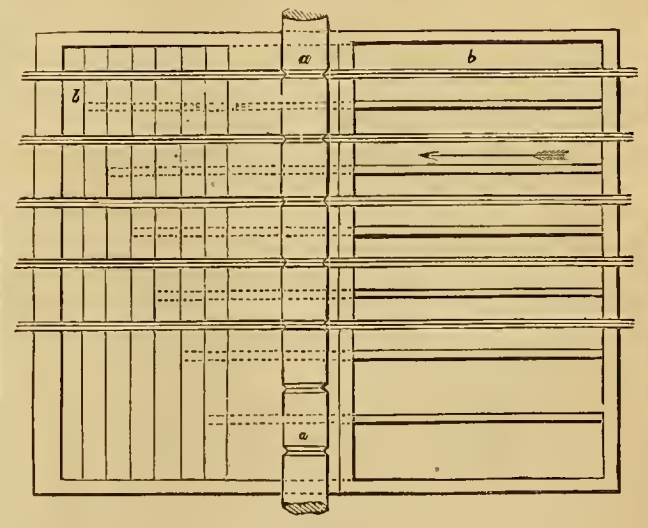
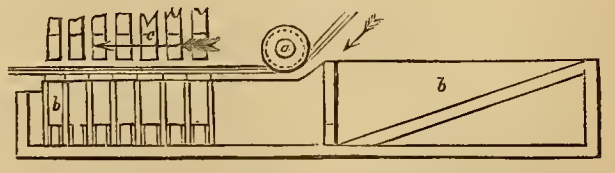


Fig. 2.

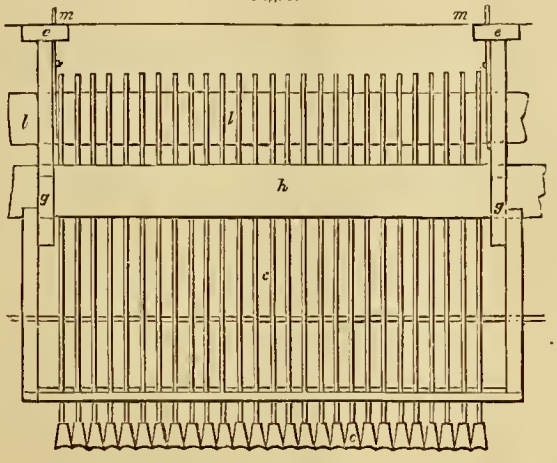


into whieh the troughs are divided. It eonsists of a rectangnlar wooden case, divided, in the front portion, into a series of narrow longitudinal eells, *b*, for the reeeption of the different eolours to be employed in printing the pattern. Eaeh of these cells has a ehannel near the bottom, as represented by the dotted lines in the plan view, for eonducting its eolour to its respective printing trough, of whieh latter there is a series eoineiding with the number of feeding eells, plaeed transversely across the colour ease, near the opposite end. The eolour is passed from the sloped bottom of the eells, as shown in the seetional view, along its channel, so as to keep the impressing troughs eonstantly charged; thus the first eell, *b*, eommunieates with the bottom of the impressing trough, marked by a similar letter, and so on throughout the series. The impressing troughs are eompletely isolated from each other at the top, by

thin division plates of wood or metal standing up a little above the surface of the troughs, and almost in contact with the threads of yarn, as they pass beneath the grooved guide-roller, *a*, in printing. Each trough is filled with layers of cloth, felt, or other absorbent material, for giving off the colour to the yarn with facility. The patentee describes a clever arrangement, wherehy he provides an excellent elastic surface for giving off the colour. This consists of a light triangular case of gutta percha, open at the top, and fitted to rest with its sides upon the supporting ledges running along the bottom of the impressing-troughs. Within this case is placed a narrow tahle of gutta percha, opcu on the underside, and perforated, at intervals, along its top. This tube is covered with thick cloth, so as to render it ahsorbent; and immediately over it, several layers of cloth are laid, so as to fill up the trough to withiu a short distance of the level of the divisiou-piecs.

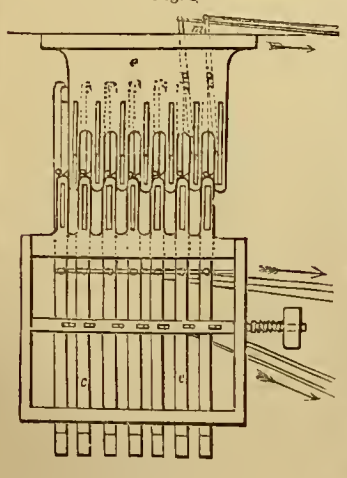
In order to render the colour apparatus more manageable, the troughs are divided, as represented in our figures, into several series of seven each, and the yarn, when applied for the purpose of printing, is also divided into the same number of parts, which is done without any prejudice to the exact execution of the pattern. This division of the colour troughs also permits of a great increase in the number of colours which may be printed at once, as each distinct case may he supplied with different colours, removeable at pleasure, so as to provide for the greatest variety which any pattern can possibly require. The yarn heams containing the yarn to be printed, are placed on the top of the front portion of the framing of the machine, and the threads are passed in suitable hundles, through guide-eyes carried by a cross-rail above the colour troughs; thence they are passed once round a tension roller working loosely in hearings beneath, and onwards beneath the grooved guide roller, *a*, which directs each bundle in a line with the lines of impressers, *c*. Fig. 3, is au elevation of one division of the impressers, as arranged in

Fig. 3.



working order, and fig. 4 is an end view of the same; they are divided into rows corresponding to the impressing troughs, each row containing a number corresponding to the extent of the pattern, or what, in harness weaving, is termed the number of cords in the tye. A series of slotted metal supporting plates, *e*, are attached to the lower surface of the cross impressing beam, here represented by the upper horizontal line; the distance between each pair of plates heing equal to the width of each division of the colour troughs, and a corresponding series of plates, *g*, are attached to upright supports carried by two cross bars of the main upright framing. Each of these plates is notched or recessed to fit the notches or recesses in the upper plates, *e*, by which the latter are guided in their vertical motion. The fixed plates, *g*, have attached to them at regular intervals seven rowsof notched bars, *h*,

Fig. 4.



represented in the end view as appearing through the upright projections of the plates. The impressers, *c*, of which there are here showu twenty-seven in length between each pair of division plates, are each composed of a thin strip of metal, to the lower end of which, a broad knob, or face of metal or other suitable material employed for giving the impression, is attached. Near the upper extremity of the thin stem of the impresser, a small pin is attached transversely for the purpose of supporting the impresser in the position shown in the annexed figures, that is, when it is out of action.

A series of vertical slots are formed in the vertical projections of the upper plates, *e*, and through each of these slots, a hroad thin har, *l*, is passed, running along the whole range of impressers. The depth of the vertical grooves containing these impressers is so proportioned that the latter may have half an inch more or less of vertical motion therein. These hars or fallers are held up against the top of their slots when out of action, hy a series of hooked detaching levers, *m*, two of which only are represented in the end elevation. Each faller is fitted with a detaching lever at its two extremities, as delineated more clearly in fig. 3; they are adjusted to oscillate loosely on stud pins fast ou the inner sides of the exterior division plates, *e*, a slight spring being attached to the plates immediately behind each lever, against which it presses so as to retain the latter in an angular position, as here represented, with its hook immediately below the faller, which latter is thus supported in its vertical slot. Each detaching lever is provided with a string in connection with the jacquard machine, which is placed at the back part of the framing near the top. These connecting strings are severally passed through a guide hoard at the back, and thence pass to the wires of the jacquard machine, holes heing cut in the pattern card purposely for this action.

Each jacquard card is made to act upon the detaching levers over its colour trough; that is to say, every red card acts upon the detaching levers over the red trough, and in like manner throughout the series. Each stem of the impressers is also guided at its lower extremity by a fixed perforated platform, through which the stems pass. A little ahove this platform, a series of horizontal spring bars are arranged to slide in grooves cut in the fixed support of the lower plates, *g*. These bars are disposed alternately with the rows of the impressers, and are notched slightly on one side, for the purpose of catching the impresser stems. One har passes before each range of stems, and it is fitted at each end with a spring spindle, as represented in the end elevation, fig. 4, aud has connecting strings passing to the jacquard machine.

The impressers are connected with the pattern apparatus by means of strings, represented in fig. 4, just heneath the lower plate, *g*. The whole of the connecting cords from each row of impressers, are termed by the patentee, "a tail," and each tail is connected to a separate roller placed at the lower extreme end of the machine. From these rollers, knotted cords pass through a holy-board to the jacquard, by which means, any single cord may be kept tight or slackened, hy catching, or being released from, the notches of the holy-board: when tightened, the cords are in a position to act upon the stems of the impressers, so as to pull them out of their retaining notches; and, when slack, no such action takes place. This arrangement of a tail action, as well as the mode of acting upon the spring-retaining bars of the impressers and the fallers, is only necessary when a jacquard machine of the common construction is employed, and is not required when a machiue with pattern cards sufficiently extensive to take in the whole of the impressers is used.

In printing by this machine, the jacquard apparatus is put in action by a winch-handle, which communicates with the pattern-barrel; and each card, as it takes its place on the barrel, acts upon the detaching levers, *m*, over the colour-troughs corresponding to the colour for which the card is perforated. The requisite detaching levers then heing drawn forward iu the direction of the arrow, the fallers, *l*, which they support, are permitted to drop to the bottom of their grooves in the plates, *e;* at the same time, the pattern apparatus also acts in a similar manner upon the horizontal retaining bars, corresponding to the particular row of fallers which have been released from their hold of. the detaching levers. The impressers heing now freed from the pressure of the spring-bars, are in a position for being acted upon by the jacquard apparatus; and the particular card which may be ou the barrel then acts according to the colours for which it is cut, in drawing forward such of the impressers as are required, so as to clear their stems from their coutaining notches in the fixed hars, *h*, when a notch, which is formed in the front of each impresser stem, comes directly below the faller. When this is the case, the cross impressing-beam is permitted to descend, carrying with it such of the impressers as have been detached, as previously mentioned, and these are now pushed downwards by the descent of the fallers, *l*, which enter each of the front notches in the stems, until the knobs of each protruded impresser sink the yarn, immediately under them, into their respective colour-troughs. Each knob or face is slightly hollowed iu the

direction of the passage of the yarn, so as to render its action upon the bundle of threads more certain. After the impression, the cross-beam is raised, and such of the impressers as have been detached, are again replaced in their fixed notches by the fallers, which, on rising, catch the hooks formed in the upper ends of the stems. According to this process, the yarn is marked with touches of colour—not in immediate contact—but in rows corresponding to the arrangement of the colour-troughs and impressers, and, in the instance before us, half-an-inch apart. This arrangement would produce no regular design if the pattern was put on the machine in the regular way; it is therefore modified to suit the positions of the colour-troughs. According to this plan, if the order of the colours is red, green, blue, yellow, brown, purple, and pink, and each line, upon which the pattern operates at once, being separated by a vacant space of equal size, then the red card of the first line will be followed by the green card of the third line; next in order comes the blue of the fifth line; then the yellow of the seventh line; then the brown of the ninth line; then the purple of the eleventh line; and lastly, the pink of the thirteenth line. Thus all the colours take effect on different lines of the pattern, separated by alternate lines, on which there is, for the time, no action; but after each stroke of the impressing apparatus, the yarn is moved forward half-an-inch, or just so much as will suffice to bring the omitted lines directly over the colour-troughs; and the second impression then forms the red of the second line, the green of the fourth line, and so on.

With a view to increasing the rate of production of this machine, the inventor has introduced a second arrangement, whereby every card of the pattern is made to act on all the rows of impressers at once. Each card is, in this case, cut with a separate row of holes for each row of impressers, and thus the whole impressing apparatus is under command at once. The patentee explains different combinations of these arrangements, adapted for the different requirements of the work, and proceeds to show how his improvements may be modified to print on cloth, or other close textures, by an arrangement of shifting colour apparatus.

In printing on close textures, as cloth or paper, the colour is derived from a row of small cells, over which feed pulleys, carrying cloth bands, are placed. These bands are charged with colour from the pulleys, and, by a simple arrangement, are passed beneath the impresser faces, to which they give off their colour, and are then returned, to permit of the impression of the faces on the cloth below.

The claims are:—

The arrangement of a colour apparatus for printing various materials.

The production of coloured patterns, or designs on yarn or threads, by immersion into colour, in place of impressing thick-bodied colour on the surface of yarn, as is now performed with blocks and rollers.

The arrangement and construction of the immersing apparatus, by which the said apparatus is made workable in connection with a Jacquard machine, or the ordinary drawing simple employed in harness weaving, or any other apparatus capable of working patterns.

The method of printing different colours at once on different lines of the pattern, together with the modification of the pattern-cards or lashes employed for such purpose.

The system of operating upon the immersing apparatus by means of a pattern apparatus, equal in compass to one row of impressers only, by the peculiar arrangement of the tail-action.

The adaptation and employment of the tail-action for the production of coloured patterns or designs on woven fabrics in harness-weaving.

The method of printing warps and other materials by the use of Jacquard cards perforated with several series or rows of holes for the different colours of the design, or by drawing all the lashes on a bridle at once, so as to obtain an increase of speed in printing.

The method of printing cloth, or other close-textured materials or plane surfaces, with various colours at once, on separate lines of the pattern.

The printing of cloth, &c., with types or impressers of any desired form, and according to any pattern, by means of the machinery described as the immersing apparatus, as well as the attachments connecting the said immersing apparatus with a Jacquard machine, or a simple and lashes.

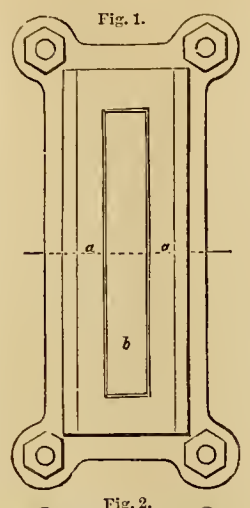
Patent for Scotland dated 29th October, 1847. *Specification enrolled 29th February*, 1848. *Drawn by* William Johnson, *Patent Office, Glasgow.*

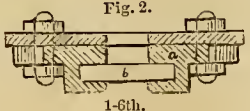
REGISTERED DESIGN.

STEAM BOILER WATER-GUAGE.

Registered for R. Robinson, Esq., *Belfast, Feb. 8th*, 1848. No. 1345.

This is an ingenious substitute for the ordinary glass guage, by which the height of the water and the state of ebullition in the boiler may be accurately ascertained. Fig. 1 is a front elevation of the guage; and





1-6th.

fig. 2 is a horizontal section as fitted to the front of a boiler. *a a* is a brass frame bolted to the front of the boiler at such a height that the working water level shall coincide with the central horizontal line. The projecting front of this frame is grooved, for the reception of a strong plate of glass, *b*, which is made steam-tight with red lead. Immediately behind the glass plate, a vertical slot is made in the boiler, so that the engineer, by looking through the plate, can see at once, the state of matters in the interior.

Any variation in the pressure may be detected by observing the rising of the steam bubbles; when the pressure is great, the bubbles rise slowly, but if the stop-valve of the boiler is opened, the change is immediately shown by the increased rapidity with which they are disengaged. As the view extends into the body of the boiler, the true water level may be always ascertained at once, as the apparatus does not permit of the vitiating influences caused by ebullition in the tubular guage. As the glass does not project to any extent from the face of the boiler, and is protected by its frame, it is safer than the tube, which is always liable to breakage, from its exposed situation.

The whole of the design is registered as new.

REVIEWS OF NEW BOOKS.

The Chemistry of the Steam Engine practically considered, being the Substance of a Course of Lectures delivered before the members of the Philosophical Institution, Birmingham. By Thomas Craddock. London: Simpkin, Marshall, and Co., 1847: Plates.

The high-pressure expansive system of employing steam has found a zealous advocate in Mr. Craddock, whose labours, practical and theoretical, are at least creditable to him, as exhibiting his energy in the cause. So far back as 1840, he patented a series of improvements in steam-engines and steam-boilers, which improvements have been from time to time modified and extended, and have led to the developement of the system advocated in the volume before us, and for which a subsequent patent has been obtained. One of the chief features bearing the stamp of invention, described in Mr. Craddock's work, is the apparatus for condensing by external cold, consisting of a revolving tubular vessel, through which the steam is passed and cooled by the contact of the exterior surfaces of the tubes with the atmosphere. This arrangement he proposes to apply only in cases where the employment of injective water is disadvantageous or expensive, as he admits that the injection condenser is unrivalled in point of simplicity, but thinks that "simplicity may be too dearly bought when it entails practical evils, and stops short of the fullest developement of the utility of the steam-engine." According to Mr. Craddock's own experiments, steam is condensed twenty-five times quicker when in contact with water than when simply exposed to the action of air; he has then this enormous balance of advantage to outweigh, before the air-condenser can be placed side by side with its rival. The theoretical advantages of the latter are, that the whole of the exhaust steam being condensed by itself, as it were, the same boiler water may be evaporated again and again, with no more diminution than that owing to escape through deficient joints and stuffing boxes. Mr. Craddock practically illustrates this premise by stating, that he has worked an engine, by way of experiment, for four weeks without replenishing his boiler; it was one of the cylindrical kind, and lost only four gallons per day when working. Applied to high-pressure engines—locomotives for instance—the objectionable stoppages for water supplies would be done away with, as the engines might run from Glasgow to London with one supply.

By way of procuring experimental proof of the soundness of his deductions, Mr. Craddock erected one of his engines at Messrs. Fox, Henderson and Co.'s works, in Birmingham, where it was worked for ten months. A laconic report upon its effect has been made by Mr. Henderson, in which he neither says or unsays anything of import, but sums up with observing that, "taking into account the additional expense of constructing the boiler—its liability to derangement and accident, I say that I believe the boiler has no practical advantage over the usual Cornish boiler, and I shall certainly prefer and use the latter." And further, "I do not feel warranted in saying more in reference to the comparison,

than that in ordinary cases, where economy of fuel is denied, and where water is plentiful, I should recommend the use of the ordinary high-pressure expansive and condensing engines; and where water is not plentiful, I believe Mr. Craddock's condenser may be applied with great advantage. Of course, always bearing in mind that I consider the whole of the mechanical details of the engine and condenser require revision and modification." With reference to this paragraph, Mr. Craddock disavows any intention of proposing his engine as a substitute for the Cornish engine, and adds a report, which was prepared by Mr. Cowper, for Mr. Henderson's use. In it he says,—

"The condenser is now, after many months' work, quite as perfect and air tight as it was when first started. There is no appearance of wear or deterioration of any kind having taken place, excepting, of course, the step brass, which is somewhat worn. The condenser has continued to give a very steady vacuum of 22 or 23 inches of mercury, according to the work put on, and the state of the weather, which does not generally affect the vacuum more than about one inch of mercury. The condenser requires about one and a half horse-power of the engine to drive it; but it enables one to obtain a much larger amount of power, in consequence of the vacuum obtained, and the means it thus gives of using more expansion than would otherwise be possible with a high-pressure engine, supposing water to be scarce or expensive. The boiler is no doubt very safe, as, even in case of a tube giving way, no serious danger would occur to any person. But the circumstance of there being so small a quantity of water contained in the boiler, necessarily occasions a greater irregularity in the pressure of the steam, supposing the fire to vary somewhat. The self-acting damper is a very ingenious contrivance, and answers its purpose very well; it is applicable to any boiler, whether high or low pressure, and is a great help in keeping the pressure of the steam regular in the boiler.

"The indicator figures I have taken off the engine, show that a vacuum of 9lbs. per square inch is fully realised in the large cylinder, supposing steam of 80 lbs. pressure per square inch to be used in the small cylinder of the engine."

We have not space this month to enter more fully into the gist of the invention, which is set forth at great length, and illustrated by eight elaborate sheets of drawings, showing the various applications of the engines to locomotive, stationary, and marine purposes.

THE PICTORIAL GIFT-BOOK; OR LAYS AND LITHOGRAPHS. The Poetry by David Vedder; the Lithographs by Frederick Schenck. Edinburgh: John Menzies. London: W. S. Orr & Co. 1848.

We do not know any work in which the sister arts of Poetry and Design are so gracefully entwined as in this joint production. In Mr. Vedder's poetry we find evidences of a graceful, and, in many respects, an original style; but our remarks have more direct reference to the illustrations as specimens of art in Scotland. Mr. Schenck, the artist to whom we are indebted for these charming plates, is a German, resident in Edinburgh, where he has long laboured to elevate and extend the art of lithography and its kindred connections.

As we turn over the leaves of his book, we are at a loss what to particularise as most deserving of mention; for we find examples of every style of the art—chromo, outline, and chalk. The frontispiece is perhaps superior, as a specimen of chromo-lithography, to anything of the kind we have before seen; its chief feature is a wreathed thistle, on a blue ground, surrounding the title. The whole is an admirable example of its class, both as regards the design and execution. The first plate is a bust of the Duke of Wellington in chalk, on a tinted ground, and surrounded with wreathes of oak and laurel, upon the leaves of which are inscribed the names and regiments of the warrior's companions in arms. "Repose at Noon" is a sweet landscape in line, representing a hay-field, with hay-makers in the foreground, reposing beneath the spreading shade of a clump of trees. Perhaps the finest specimen of chalk drawing is a head of Shakspeare, and we question whether any artist in Britain can show a superior work.

In outlines, we find a monument now erecting to Frederick the Great at Berlin; and another in honour of Guttenberg, Faust, and Schoeffer, the three founders of the art of printing. This is being erected at Frankfort-on-the-Maine. The lining of these is clear and accurate, and the more minute details exhibit a marvellous degree of finish. As pen drawings we have an illustration of Mr. Vedder's "Stanzas to Ayrshire," and "Baron Von Flateau's Cogitations." A design of Kaulbach's, the "Emperor Frederick Barbarossa," furnishes an exquisite example of the hitherto much neglected art of *engraving on stone*. The concluding plates are "The Aurora Borealis," as seen from the Orkney Islands, and "Loch Eil" from Fort-William, in chalk. The work possesses the very great merit of excellence in every variety of its contents, as in each particular style the artist's hand appears to advantage. The volume, which we perceive is dedicated to Alexander Cowan, Esq., may be deservedly classed amongst the best works of its kind.

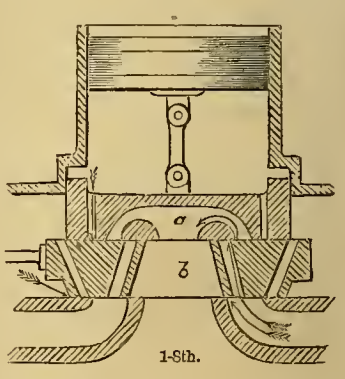
THE TRADESMAN'S BOOK OF ORNAMENTAL DESIGNS. Part X. Conclusion. London: W. S. Orr & Co., Paternoster Row. Edinburgh: J. Menzies.

We have before accorded this serial so full a notice, that little more remains for us to add, except the record of its early conclusion. The present Part, like its predecessors, contains four plates; the first is a damask table-cover—Grecian; the second, a series of six Flemish designs for paper hangings, which are eminently chaste and beautiful; the third is devoted to patterns in lace-work, and contains three specimens of the Louis Quatorze, Flemish, Moorish, and Arabesque styles; and the last presents three examples of perforated rail—Egyptian. A reference to the forty plates contained in the work, shows how large a fund of material is provided for Ornamentalists of all grades and classes; and the thanks of the student are equally due to Mr. Leith for the excellency of the artistical department, and to Mr. Ballantyne for his "Essay on Ornamental Art."

CORRESPONDENCE.

IMPROVED SLIDE-VALVE.

The accompanying sketch represents a locomotive slide-valve, modified to facilitate the access of steam to the cylinders. I hope you will not catalogue it as one of the "endless gimeracks," as I think it may be valuable for valves of a quick motion. The upper valve, *a*, is a fixture, being held in its place by snugs on its four corners, which are fitted to the corners of the steam chest. This valve is placed upon the working valve, *b*, which slides on the cylinder face, the combination forming a species of gridiron valve, admitting the steam in double quantities. As here represented, the valve is on the centre, no steam being admitted to either end of the cylinder; but if the valve, *b*, is moved from left to right, two thoroughfares will be open for the admission of the steam into the ports on the right side. The arrows pointing to the upper and lower surfaces of the valve, *b*, will explain this; thus, when the port at the extreme end of the valve arrives beneath the corresponding port in the fixed valve, steam will find access to the cylinder through the two valves, as indicated by the arrow; and, at the same time, the valve, *b*, will also have partially uncovered the cylinder port, so as to afford a passage for the steam in the same manner as in the ordinary slide-valve. The same occurs on the exhaust side: the exhausting cylinder port is put in communication, at each stroke, with the extreme port of the central exhausting thoroughfare of the fixed valve, and, at the same time, the central exhaust port of the slide-valve is itself brought into communication with the cylinder port, so that two routes are provided for the escape of the steam. I have before seen double valves with the duplex steam passages, but in all of them the exhaust was single. As large valves of this kind are occasionally liable to seize in working, I have represented a small cylinder, as substituted for the steam-chest cover, which cylinder is fitted with a piston, to balance the pressure on the back of the slide. I may observe, however, that if the valves do not seize at the commencement of their working, they seldom give any trouble afterwards; and I think that, if care is exercised in lubricating them for the first few days of the engine's running, they will work well.



M. W.

Squirrel's Heath, Romford, Essex.

WHAT IS ELECTRICITY?

May I be allowed to circulate, through the medium of your scientific periodical, my own solution of the above important question?

Electricity is a principle that pervades all creation; everything that exists, whether animate or inanimate, is influenced by it in some degree. The nature of this grand principle, as well as its constitution, are alike inexplicable: but from facts and reasonings I am enabled to say, that light, heat, and electricity, are but different effects of one grand principle in nature. Dr. Faraday has trodden a little way in this path; he has proved that a beam of light can be influenced by a magnetic current, and has feebly put forth the idea, that light and magnetism are identical; but I go farther, and say—and will maintain, that light, heat, and all kinds of electricity—animal, frictional, voltaic, and thermal—are identical in their nature, though different in their effects; and I confidently

assert, that they all proceed from the same grand universal principle;—this is my thesis, which I will now endeavour to prove.

Light, whether solar or terrestrial, produces heat. Wherever there is combustion, there will be also light and heat. The light we see, the heat we feel, common electricity produced by the electrical machine, causes light, as is shown by the electric spark. Charcoal presented to an electric current, artificially produced, causes light. In fact, it would be useless and tedious to mention the many ways in which light may be produced by electricity. Heat is also produced by electricity. The single experiment by which gold leaf is burnt, sufficiently proves this. Franklin discovered that lightning was of the same nature as common electricity, by conducting it down an iron chain or wire, and drawing a spark from it. Lightning often sets buildings on fire; therefore, I say, it is plain that it produces both light and heat. The above, and numerous other experiments, originated by clever philosophers, incontestably prove that electricity produces both light and heat, and that lightning is only an accumulation of electricity. Celestial electricity is, then, of the same nature as terrestrial.

By a modern experiment, the identity of the solar rays with electricity is also proved. From these, and other facts, I am able to say, while the sun supplies this world with light and heat, it also furnishes it, and every body upon it, with a regular supply of electricity. I am led to consider the sun as the great reservoir of light, heat, and electricity; and that our light, which is supplied daily, is similar to, and produced in the same manner as, the light that is evolved from an electric current, by the presentation to it of charcoal points, or any other conductor. The earth presents a portion of her surface to the sun, day by day, and then draws from that immense reservoir, the electric spark that supplies us with light and heat, and tends to maintain a just equilibrium of the electric principle in all things. Let us suppose this principle to be abstracted from our globe, and the result is, that we could not then produce either artificial light, heat, or electricity. The sun, then, is the body whence the earth obtains her supply. We know that when an increased quantity of electricity is given to any substance, its equilibrium is restored by connecting it with the earth. The effect, then, of the electrical machine, is to abstract from one substance and add to another, thus producing wonderful effects unseen, when nature is undisturbed. It is absurd to admit the existence of two kinds of electricity. It can only differ in quantity, and not in quality.

The experiment determining the electric effect of the sun's rays is the following:—Darken a room, and through a hole in the door or shutter admit a solar ray: this will be seen to possess light and heat. On presenting an insulated metalic conductor to the ray, the electric principle will be given to it in an increased proportion, and sparks may be drawn from it by presenting to it the knuckles, or any conducting body.

The discovery of this grand principle will effect quite a reform in the theories of light, heat, and electricity. C.

Birmingham.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.—March 21, 1848.

Joshua Field, Esq., President, in the Chair.

The paper read was a description of "A method of setting out Railway Junctions." By Arthur Beaulands.

The object of the paper was to supply a methodical rule for setting out that portion of a branch line of railway included between the rails of the main line.

The author observed, that in all ordinary cases, the curve of the branch line could not be set out from the main line, which was supposed to be straight, by the ordinary methods of setting out railway curves, since the junction was required to make an offset of four to five inches on the length of the switch rail, which was much greater than the offset made from the tangent in the same length by a curve of moderate radius, so that it was necessary to make the junction line start abruptly at a finite angle with the main line.

He therefore considered the junction curve to be determined by its passing through three given points; namely, the two extremities of the switch rail, and the farthest point of crossing; and from these data he showed how the radius and centre of the circular arc might be found, as well as the positions and angles of the various crossings. To render the method more easy of application, the author gave a table calculated from the principles and formulæ laid down in the paper, assuming an ordinary form of the switch, and a series of values of the lead, a distance of the furthest crossing extending to the greatest limit likely to occur in practice. In the course of the discussion which ensued upon this method as compared to the ordinary system of setting out junctions by a comparatively empirical rule, well understood and practised by the platelayers on railways, Mr. Wild's switch was alluded to and exhibited. In this switch all notching and inequality in the bearing surfaces of the fixed rails were shown to be avoided, by the end of the tongues being housed under such surfaces instead of being notched into them; the tongues being consequently at their points, and for some distance beyond them, lower than the fixed rails, exercised, where they were weakest, merely a lateral action against the wheels without bearing any of the weight of the passing trains.

Several engineers, who had employed these switches extensively, expressed themselves relative to them in very commendatory terms, and stated that they were not only manufactured in a very superior manner, but that their action was very perfect, and that they tended greatly to the prevention of accidents in railway travelling.

March 28.

The paper read was "The Engineering of the Rhine and the Moselle." By Mr. G. B. W. Jackson, Assoc. Inst. C. E. This communication was written during a short visit made to Holland for the purpose of inspecting personally the works with which the author had become familiar in the writings of Beaudemoulin, Vanden Bergh, Defontaines, Hibbert, Krayenhoff, Ockhart, and Wiebeking. It commenced with tracing the geographical course of the Rhine, from its source on the Badus, in the canton of the Grisons, to its numerous outfalls into the sea. It then treated at considerable length the geological character of the country through which the river and its branches thus traversed. The ancient works, as far back as the time of the Romans, were then briefly described; and the general state of the bed of the river with the comparative levels, the inclination, and the velocity of the stream, at the commencement of the modern works, were then laid down in a tabular form, as points of data; and then the capability of the Rhine for forming banks, by warping or depositing the matter held in suspension, was discussed.

The remainder of the first part of the paper was then occupied by descriptions of the modes of straightening the bed of the river, and of constructing the dams, weirs, division arms, spurs, and shoreworks, and the method of blasting the rocks, which latter considerably impeded the course of the stream. Our limits will not permit us to follow the detail of these works, which differ so essentially from any in our own country; but the whole proceedings appeared to be given with such precision, that the paper, when it is published at length with the copious details with which it was illustrated, will form a most interesting portion of the minutes of proceedings.

April 4.

The second part of Mr. Jackson's paper "On the Engineering of the Rhine and the Moselle" was read. It consisted, to considerable extent, of a translation of an account of the Spurs, Groynes, and other works on the Moselle, for restricting the dimensions of the bed of that river, and increasing the depth of the water, so as to enable the navigation to be carried on, which would otherwise be averted in the low water seasons. It was shown, that to effect this, numerous arms of the river had been dammed across and allowed to silt up, the course had been straightened, elbows had been cut off, and the convex shores, after being silted up by deposit between the groynes, were defended by arming of fascines, &c. Division banks had been established for the inflowing rivulets, so as to carry the gravel to greater distance down the stream. Rocks also were removed by powder, and general improvements to such an extent were executed, that the river was comparatively under good control.

The account of the Rhine was then resumed, and after detailing the various plans that had been proposed for ameliorating its course, giving numerous interesting and valuable tables of Blankin's and Bolstra's experiments as to the tides, the inclination of the bed of the various rivers, the duration of the ebb and flow, and average height of the river at the time of new and full moon, the height of various dykes above the extraordinary flood line, &c., the paper finished with three general views. "On looking at the map of Holland, and tracing its various streams, it does not appear at all singular, that frequent ice stoppages should take place in that country, whilst such occurrences are comparatively rare in Germany; for, as long as the Rhine retains its single course as at Emmerick, no obstacle, excepting elbows, stay the progress of the current seawards; but as soon as it divides at the Waal and Pannerdea canal, the soil commences and increases, according to the number of arms and channels lower down. It is generally agreed that a river should have as few outlets as possible, in order to allow it the more effectually to clear itself, and that the tide should be admitted as far as possible; whilst, at the same time, the action of the wind should be diminished. Again, that the more the surface of water of any river is abstracted, the more quickly the sand will accumulate; and also, that if a cut be made, it is usual for ice stoppages to take place below it, so as to raise the water level above. And it is also agreed that, if a cut be made as capacious as the river itself, or be permitted to increase to that extent, it will soon get beyond control, whilst the sand will accumulate rapidly, and, that when openings exist in dykes, the ice gets into eddies, loses its velocity, and by degrees closes up the passage below the opening, so as to raise the waters above. The question therefore to be solved with regard to Holland, and the system followed there in order to prevent breaches in dykes, and to save the better part of the country (taking into account its weak marshy soil, and its incapacity to withstand any great force), is whether it be the better plan to relieve the pressure on the dykes, by cuts and new channels, and local floodings, at the expense of increasing the number of ice stoppages, at the same time diminishing the velocity in the main river, thereby greatly augmenting its liability to accumulating sand. It is true, as already stated, that the rivers are at present in such a condition, that it must be very expensive to effect anything of importance; but the question is of such vital importance to the port of Rotterdam, and the certainty of the mouth of the Meuse at the Brielle, in the course of time, closing up like that at Katwyk, if no improvement be attempted, is so clear, that it is very much to be regretted some steps have not been taken ere this to prevent so great a flow of water from passing out by the Hollands diep to Hellvoet. The author directs the attention of the Institution to this subject, and submits the following points for the consideration of the members. That the object to be aimed at, in any steps which might be adopted for improving the Meuse at Rotterdam, should be to protect and strengthen the shores and dykes likely to be operated upon by the alterations—to straighten all the curves on the Leck, so as to

lessen chances of ice stoppages—to separate the Waal and Meuse waters as much as possible, and to lead off the former together with the Leek into the sea, by the Brielle—to narrow the Breshosch channel (now divided) into one, regulating the quantity of water—to close the Krahbe, the Noord, and the Sprey, with sluice gates—and, for the purpose of widening the outlet, to join the Island of Rosenburg to the main land at Vlaardingen, thereby causing the ebb waters to act upon this island, and with increased velocity, and an additional quantity of water attempting to remove the bar and shoals.

At the Monthly Ballot, Messrs. F. C. Penrose, R. Hughes, H. Curry, F. P. Smith, and S. Wood, were elected as Associates.

April 11.

The paper read was the second part of a communication made in the year 1841, descriptive of the "Bann Reservoirs, County Down, Ireland." By J. F. Bateman, M. Inst. C. E.

The first part, of which a short abstract was read, gave the object of the construction of these reservoirs, which were undertaken with the view of regulating the quantity of water in the River Bann, and more effectually supplying water-power to the flourishing and increasing establishments on its banks; this river is, from the bare and naked character of the Mourne mountains, among which it rises, naturally liable to the greatest irregularity in its volume. Devastating floods frequently pour down the channel, where a few hours previously there was not sufficient water for agricultural purposes. Greatly injurious as this must have been to the agriculturist, it was infinitely more so to the mill owners, who depended entirely upon water-power for their manufactories.

Mr. Fairbairn was consulted on the subject. He examined the locality, and advised the formation of reservoirs. The author was then appointed the engineer, and acting in some degree upon the suggestions of his predecessor, whom he continued to consult, the works were undertaken which are described in the present paper.

The peculiarities in the act of parliament, granted in 1836, constituting the proprietors of the mills a Joint Stock Company, for the formation of the Bann reservoirs, are detailed.

The works were originally intended to have been more extensive than have been really executed. The reservoir at Lough Island, Reavy, is alone described. The ground on that spot was admirably adapted for the work, being the bottom of a basin, which was bounded on all sides by rugged hills of granite. In the centre of the basin was a small lake, at the bottom of which was discovered a bed, several feet in thickness, of fossil *confervæ*, similar to those discovered by Professor Silliman, at Massachusetts, North America. This interesting geological fact was first noticed by Dr. Hunter of Bryansford; the confervæ appeared like an impalpable powder, but when viewed through a powerful microscope, they were found to be regular parallellograms, many of them covered with striæ. They are described by naturalists as the fossil skeletons of minute vegetables.

The situation fixed upon for the reservoir rendered necessary the construction of four embankments between the hills, so as to raise the water to a height of thirty-five feet above the summer level of the lake.

The particulars are also given of a series of observations, with rain guages, continued for two years, for the purpose of furnishing data for computing the extent of reservoir which would be necessary to insure a supply of water throughout the year.

The continuation described the subsequent works, which consists of the Corbet Lough reservoir, which was designed as an auxiliary pond, to receive the flood waters of the lower part of the river, and to retain the night water, to be discharged again during the day, immediately above the more extensive mills on the river. A water course of considerable dimensions was constructed; to effect this end, an embankment was thrown across the narrow outlet of the lake, the water being admitted through self-acting flood gates, which closed as soon as the lowering of the river created a current in the contrary direction. The details of the construction of all these works were given, and it was shown, by calculation, based upon actual experiment and observation of the quantity of water received, stored, and delivered from the reservoirs, that their construction had increased the value of the mill-power of the River Bann full five-fold, at a comparatively very insignificant cost, as the actual expenditure for the works at Corbet Lough did not exceed £3,300, the closest economy, consistent with the efficiency and durability of the work, being rigidly kept in view, and the utmost attention being exercised by the resident engineer.

April 18.

The paper of the evening was a series of "Observations on the Resistances to Railway Trains at different velocities." By Mr. Daniel Gooch of the Great Western Railway.

For the purpose of performing the experiments a dynamometer carriage was constructed at Swindon, in which all the results required were registered upon a large scale on the same roll of paper, thus exhibiting at one view, and in the same period of time, the tractive power exerted upon the train, and the force and direction of the wind; the registration of the results was made upon the paper at every sixteenth part of a mile, and the time was registered in correspondence with the distance traversed during every fifth part of a second.

The dynamometer spring used was seven feet six inches long, and very carefully arranged. It was only necessary to count the number of seconds or fractions of a second in one or more of the distance divisions, and the speed was accurately ascertained.

The force and direction of the wind was ascertained by a wind guage, placed five feet above the top of the carriage, with the connexions brought down to pencils, which indicated on the same sheet all the results.

Indicator cards were also taken simultaneously from the steam cylinders as frequently as was practicable, but not continuously, as it was a service of some danger, the experimenter being obliged to sit on the buffer beam of the engine, at a velocity of sixty miles per hour, and in that windy position, to take off four sets of cards in three quarters of a minute. The spot selected for performing the experiments was one mile of railway perfectly straight and level, and nearly on the surface of the ground, and in the plan the height of the trees, hedges, and every intervening objects which could affect the influence of the wind, is clearly marked.

The experimental train consisted of first and second class carriages, each on six wheels, four feet diameter, taken indiscriminately from the working stock, and loaded with iron, to represent a fair load of passengers, giving a gross weight for each coach of ten tons.

The experiments were tried with various weights and speeds up to one hundred tons, and to sixty-two miles per hour, and the results were classified and arranged in a tabular form, with copious explanatory headings, so as render reference to them exceedingly easy.

The author first received the deductions of Mr. Wyndham Harding's formula, which was given at the discussion at the Institution, in 1846, and gave his reasons for dissenting from the formula.

He then examined critically several experiments recorded in the tables, stating candidly all the exceptions that could be taken to them, showing also, that although there was a difference of as much as fifty-two per cent. shown between the resistance, as calculated by Mr. Harding's formula, and the experiments made by Mr. Gooch, that difference might be accounted for by the methods employed by Mr. Harding, which were objected to, as calculated to produce erroneous results, viz:—allowing carriages to run down inclines by their own gravity—using wheels of three feet diameter instead of four feet—having a much greater length of train for the wind to act upon, &c.

He reviewed the great effect of a side wind against a train, driving the flanges of the wheels against the rails, and argued that the length of a train of carriages was much more important than its weight.

The author did not offer any formula that should be applicable for calculating the resistance of all railway trains: but his tables gave examples of almost every case that could occur, and thence data could be supplied for those who wished to carry the investigations farther and make a formula for themselves.

He arrived at the conclusion, that in practice the friction of the axle journals was not a constant quantity at all speeds, and thought that the number and diameter of the wheels should form elements in any general formula. He showed by experiments that the total atmospheric resistance to a train weighing fifty tons, differed but slightly from that to a train of one hundred tons weight, if the carriages were small and the train long in the one case, and the reverse in the other case.

The general results of the diagram of resistance with trains of one hundred tons, and with fifty tons, showed that the resistance calculated by the narrow guage formula with a fifty ton train at sixty-two miles and a-half per hour, was thirty-seven pounds. With a train of one hundred tons by the same formula at sixty-one miles, it was thirty-one pounds and a-half. The broad guage resistance with a train weighing fifty tons at sixty-two miles and a-half per hour, was under twenty-three pounds; and with a train weighing one hundred tons at sixty-one miles and a-half per hour, was twenty-two pounds and a-half. [We cannot of course give the results in full, except in a comprehensive form; but such were the general results.] The author then concluded his paper by saying that it appeared to him to be necessary, that before any general formula for calculating the resistance to railway trains would be made, that the value of the following elements, necessary in such formula, should be determined by experiments.

1st, The axles' journal friction at different velocities, and with different weights per square inch of journal surface.

2d, The resistance to the rotation of the wheels and axles per pair, at different velocities and with different diameters.

3d, The resistance due to the rolling of the wheels upon the rails, with different weights upon them and with different diameters.

4th, The resistance due to the passage of the train through the atmosphere at different velocities, with different proportions of weight and length, and breadth of train.

5th, The resistance due to the oscillation or unsteady motion of the train at various speeds.

The author considered that all these values might be determined with a considerable degree of accuracy, by careful experiment.

ROYAL SCOTTISH SOCIETY OF ARTS.

["Exposition on the strength of materials, particularly Cast Iron and Malleable Iron, and their application in the construction of Railway Bridges." By George Buchanan, Esq. Concluded from page 22, Part I.]

The effect of the transverse strain was then considered and illustrated by various experiments and models. The strain is a compound of the tensile and compressive strain, the one part of a beam loaded in the middle being compressed and the other distended, and the beam itself becoming a lever, and acting often with enormous power against its own strength. Hence it became easy to calculate the strength, this being in every case proportional in the first instance to the area of the section of fracture, and this original element modified by the length and depth of the beam, diminishing in exact proportion to the length, and increasing in proportion to the depth.

The transverse strain acting with such severe advantage against our materials, various methods have been contrived for eluding its effects, and of these none is more remarkable than the principle of the arch, the effect of which was illustrated by ex-

periments, and particularly the necessity in flat arches of having secure abutments to resist the horizontal thrust; and this was frequently accomplished, where there is sufficient head-room, by uniting the extremities of the arch by strong malleable iron rods, in the same manner as in the case of the roof, the feet of the rafters are united and prevented from spreading by the tie beams; and this is the principle, the securest of all, on which the great iron bridge at Newcastle, now in progress, is constructed, the object of which is to cross the river and valley of the Tyne, on the highest level of the railways on each side, so as to unite them in one uninterrupted line from London to Berwick, and unite the termini of the different railways, now separated three quarters of a mile or more, into one grand central station, a little to the west of the ancient castle. The distance between this station and the present terminus of the York and Newcastle railway is 3457 feet, consisting chiefly of the space occupied by the bed of the river Tyne, and the steep banks on each side, well known to travellers in descending from Gateshead Fell on the south, and Dean Street on the north, both to be now superseded by the smooth and level surface of the railway, and by a turnpike road running on the same bridge directly under the line of rails. The steep banks on each side are spanned by stone arches of a very substantial character, the river and low banks by six metallic arches, all of the same dimensions and structure, resting on solid piers and lofty columns of masonry. In the bed of the river the piers are laid on very solid foundations of piles and planking, with concrete, many of the piles 40 feet in length, and driven to this depth through hard gravel and sand till they reach a bed of freestone rock. Nasmyth's celebrated pile-driver is in full operation here, and with wonderful effect, and has come most opportunely in aid of the work; driving night and day, at the rate of 60 or 70 strokes a minute, the pileheads being often set on fire by the rapidity and violence of the blows of the ram. Piers laid 2 feet below water mark, and raised about 100 feet to the springing of the arches. The arches consist each of 4 main ribs of cast iron, each in 5 segments bolted together, and forming one entire arch 125 feet span, and rising 17 feet 6 inches in the centre, and the level of the rails on the upper platform 108½ feet above the level of high water mark of the Tyne. Depth of the rib 3 feet 9 inches at the springing, and 3 feet 6 inches at the crown, with flanches 12 inches broad, external ribs 2 inches thickness of metal, internal ribs 3 inches. Total sectional area at the crown 644 square inches, which would bear with safety a load of 5000 or 6000 tons, and would form, with proper abutments, a strong arch in itself; but for the fullest security, and to prevent the possibility of inconvenience or risk from deflection or vibration, or otherwise, each rib is united at the springing by strong malleable iron bars or ties, 7 inches broad, and 1 inch deep, of the best scrap iron, and in all 24 in number. The railway is supported above the arch, and the roadway suspended from beneath, by hollow cast iron pillars 10 feet apart, and each 14 inches square, through which are passed strong malleable iron circular bars, binding the whole into one stiff and solid mass. The sectional area of the horizontal bars is 168 square inches, which would sustain upwards of 4000 tons without breaking, and 1500 tons with perfect safety; but the whole weight of the bridge will not exceed 700 tons, leaving 800 tons of surplus strength. The railway, which is at the summit level, runs on a level of 4 feet above the crown of the arched rib, and is supported in the middle by hollow cast iron trough girders, resting on the top of the pillars 10 feet apart, and united by longitudinal timbers laid with strong planking. The roadway runs nearly on a level with the malleable iron ties, leaving a space of about 20 feet clear head room.

In the whole of the work the utmost pains has been bestowed on materials and workmanship, and in making everything complete, the surfaces, which abut together, being regularly planed or turned, as in machinery; and from all the arrangements the most successful results may be anticipated from this bridge. The cost of the iron work and roadway, by the estimates, come to £112,000, and the contracts for the bridge and viaducts above 300,000.

March 13.

A paper was read by Mr. Purdie, "On the Production of the Beautiful"—an attempt to prove that the theory advocated in the papers read by Mr. D. R. Hay before the Society, founded on the Developement of the Harmonic Ratios, is fallacious.

This is a lengthy production, directly opposing Mr. Hay's Geometrical Theory of Beauty, to which it bears an almost exclusive reference, and for this reason we are compelled to omit it.

April 10.

I.—Part II. of Mr. Buchanan's paper on "The Strength of Materials," with an account of the tubular bridges over the Conway and Menai Straits, was read.

Some inquiry having been made regarding the Bridge over the Tweed, the only remaining link, uncompleted, between London and Edinburgh, Mr. Buchanan had obtained some particulars of that structure from Mr. Harrison, the resident engineer under Mr. Stephenson. The bridge is to be of stone, and is to consist of 28 semicircular arches, each 61½ feet span, resting on lofty piers, carrying the level of the railway 103 feet above high water mark, 126 feet above low water mark, and 135 feet above the deepest part of the bed of the river. The whole length of the bridge, with abutments and wingwalls, is 2140 feet. The 28 arches are divided into two series by a broad pier, 28 feet in thickness in the middle. The piers of the arches are 8½ feet in thickness at the springing, increasing by steps towards the bottom. The bridge will not be completed for 16 or 18 months, but it is intended to have a temporary bridge ready for traffic in the month of July next. This viaduct is a work of great magnitude, and will form, when finished, a striking and imposing structure, and one of the many to which the extension of railways has given rise. While on this subject, he mentioned two other remarkable works recently designed and executed by Mr. Miller, on the North British and Ayrshire Railways. The one is the viaduct over the valley of Dunglass, between Dunbar and Berwick, not far from the once celebrated Pease Bridge. This viaduct crosses the valley and banks by 6 semicircular arches, each 60 feet span, and then the deep ravine by a single arch 135 feet span, and rising 105 feet above the bed of the stream. A large and beautiful model of this structure was exhibited, which Mr. Miller, at the President's request, had allowed to be shown to the Society. The other viaduct is that of Ballochmyle, across the Water of Ayr, on the Cumnock Extension of the Ayrshire Railway, and is similar to that of Dunglass in crossing the valley on three semicircular arches, each 50 feet span on each side, but is still more remarkable in crossing the deep ravine in the middle, by a single semicircular stone arch, no less than 180 feet span, and rising 150 feet above the bed of the stream—a bold and noble design, and which has been executed with complete success, the adjacent rocks furnishing such vast blocks of stone as greatly to facilitate the construction, and to render, indeed, the plan itself practicable. The arch stones are 5 feet 3 inches deep at the springing, and 4 feet 9 inches at the crown, and the appearance from below of the stupendous arch rising to such a height, is singularly grand and striking. The whole arrangements connected with the quarrying and raising, and depositing the stones on the building, by the improved machinery of modern times, have been most efficiently conducted by the contractors, Messrs. Ross and Mitchell; and the simple mode of centreing adopted and shown in the Dunglass model, is recommended by the advantage of preserving the timbers entire.

MONTHLY NOTES.

Mahogany v. Oak,—Mahogany has lately been introduced with great success into churches, the entire fittings having been constructed with it, the roof being the only part where fir timber has been used. The effect which has thus been produced is most striking, as the benches, altar rails, screen, and pulpit, are made entirely of mahogany. Where decoration has been used it harmonises most happily with the painting, and gives a richness and warmth to the interior of the building which no other wood could impart. It is not going too far to assert that, before long, our churches will be as universally fitted up with mahogany as our dwelling houses are now furnished with that material; and had it been known to our ancestors, and been as accessible to them as it is at the present time, there can be little doubt but it would have been generally used for the carved work and fittings of our old cathedrals and churches, because it would have been found to have harmonised with the rich colours with which the churches were then decorated, and it would also have been preferable to oak on account of its being nearly imperishable, and much more easily worked, and of larger sizes; and now that it can be obtained at the same price as that wood, it cannot fail to be extensively used in all sacred edifices.

Anastatic Printing.—The Rev. H. E. Strickland of Cambridge, has lately been instituting some inquiries as to the capability of the anastatic system, for a more general application than it has hitherto received. In the course of his experiments, he has succeeded in effecting excellent transfers of lithographic chalk drawings. The so-called metallic paper, as prepared for writing upon with metallic pencils, is found to be the best material upon which to execute the chalk drawing to be printed. Impressions from the zinc anastatic plate, the drawings of which have been originally made on this paper, have an appearance very closely approaching to that of a good lithograph. Fine drawing paper, smooth, but not glossy, is the next best material. The lithographic chalk must be hard, and cut to a fine point. Mr. Strickland terms his productions *papyrographs*; he says, that, although their general appearance resembles a lithograph, yet, when examined through a lens, they exhibit a different texture. This is in consequence of the peculiar formation of the paper surface, which consists of *horizontal fibres*, whilst that of the stone approximates to an arrangement of minute conical points. He is of opinion that paper might be made of a surface analogous to that of the stone, by adding to the pulp, finely powdered mineral matter. A calcareous substance would effervesce with the acid employed in transferring; silica would be too gritty, but probably aluminous matter, as brick-dust, might answer, if added in due proportions. The advantages of the new process are not artistic, but practical; it is not contended that the draughtsman will be enabled to produce results at all superior to what he accomplishes by the existing arrangement, but it presents facilities for the execution of drawings, which lithography cannot possess. No weighty stones are required, and the artist may have his sketches printed off immediately, without copying or revising. The process is also a rapid one, insomuch that, some plates may be published within half an hour after the time they are finished by the draughtsman.

Gilded Silk.—The late discovery of a chemical method of gilding silk, is a striking proof of the good effect producible by the judicious distribution of the prizes of scientific societies. For many years back, the Prussian Industrial Association has regularly announced its intention to award a prize of 1000 thalers (£150), in addition to the large gold medal of the society, for the discovery of such a process, on condition that the silk should undergo no alteration in other respects. A very few imperfect specimens were produced by this liberal offer, and the society found it necessary to extend the term appointed for receiving communication on the subject, from time to time, until about three months ago, when Dr. Kroning, of Stolberg, in the Hartz mountains, having accidentally heard of the proposition, applied himself diligently to the task of discovery, and after several failures, succeeded in gilding silk to the highest perfection. The process is equally applicable to the woven and unwoven material, which possesses a splendid metallic brilliancy, whilst its original flexibility is unimpaired. When soiled, a washing in soap and water, and light pressure, restores its beauty. The variety of applications of which the silk is capable, is immense, for by its combination with other colours, magnificent designs for ribbons, dresses, &c. may be produced. Its adoption will effect a complete change in the present manufacture of gold lace and cord.

ENGLISH PATENTS.

Sealed from 22nd March, 1848, to 20th April, 1848.

George Ellins, Droitwich, Worcestershire, salt manufacturer,—"Improvements in manufacturing salt, and in apparatus for manufacturing salt."—March 22d.

William Edward Newton, Chancery-lane, Middlesex,—"An improvement or improvements in making coupling joints for pipes, nozzles, stop-cocks, mill and cylinder beads, and other apparatus." (Communication.)—22d.

Henry Bessemer, St. Pancras-road, Middlesex,—"Improvements in the manufacture of Glass."—22.

William Henderson, Parkhead, Lanarkshire, Scotland, chemist,—"Improvements in treating lead and other ores."—22d.

Joseph Orsi, Guildhall Chambers, gentleman,—"Improvements in the manufaeture of artificial stone cements, ornamental tiles, bricks, and quarries."—(Communication.)—22d.

William James Dailey, Lambetb, Surrey, lithographer,—"Improvemeuts in macbinery for propelling."—22d.

John Lawes Cole, Lucas-street, Middlesex,—"Improvements in steam-engines."—22d.

Benjamin Gray Babington, George-street, Hanovcr-square, Middlcsex, M.D., and John Spurgin, Guildford-street, Middlesex, M.D.,—"Improvements in the manufaeture of metallic pens."—27th.

John Coates, Seedley, Lancashire, calico printer,—"Improvements in machinery or apparatus for printing calicoes and other surfaces."—April 4tb.

Michael Joseph John Donlan, Esq., Abbots, Bromley-house, Staffordshire,—"Improved eompounds or mixtures to he used for lubricating machinery."—4th.

James Pilbrow, Tottenham, Middlesex, engineer,—"Improvements in propelling upon railways and canals, and in tbe apparatus or macbinery by whicb tbe same is to be accomplished."—4th.

Thomas John Knowlys, Heysham-tower, near Lancashire, and William Fillis, Shirley, Hants,—"Improvements in generating, indicating, and applying heat."—5th.

Joseph Foot, Spital-square, Middlesex,—"Improvements in tbe manufacture of sieves."—5th.

Eugéne Ablon, Panton-street, Haymarket,—"Improvements in increasing tbe draft in chimneys of locomotive and other engines."—8th.

Thomas Gill and John Edgcumbe Gill, Plymoutb, manufaeturers,—"Improvements in the manufacture of manure."—8th.

Thomas Potts, Birmingham, brass tube-maker,—"Improvements in the manufactnre of tubular flues of locomotive and other steam boilers."—10tb.

Thomas Spencer, Prescot, Lancashire,—"Improvements in machinery or apparatus for manufacturing pipes and tubes from clay or other plastic materials, part or parts of wbich improvements are applieable to the manufacture of hollow earthenware."—10th.

James Derham, manager of Thomas Willett and Co.'s spinning-mills, Bradford, Yorkshire,—"Improvements in macbinery for carding, combing, preparing, and spinning eotton, wool, Alpaca, mohair, flax, silk, and other fibrous materials."—10th.

John Ecroyd, Rochdale, Lancashire, machine-maker, and John Eccles, of the same place, mechanic,—"improvements in valve or plugs for tbe passage of water."—10th.

James Perrie, Rochdale, Lancashire, engineer,—"Improvements in steam-engines."—10th.

John Longworth, Newton-heath, Laneashire,—"Improvements in pickers for power looms."—10th.

James Meacock, Liverpool, gentleman,—"Improvements in preventing and extinguishing fire in vessels, warehouses, and other buildings, part of which improvements are applicable to ventilation."—12th.

John Masters, Leicester, gentleman,—"Improvements in dress fastenings and in attaching the same, and in articles made wholly or in part of certain flexible materials or fabrics."—12tb.

Henry Henson Henson, Hampstead, Middlesex, gentleman,—"Improvements in railway carriages and waggons, and in vessels of capacity employed in the storing and conveyance of explosive substances."—15th.

Thomas Forsyth, New North-road, Middlesex, engineer,—"Improvements in tbe manufacture of railway wheels."—15th.

Charles Green and James Newman, manufacturers, Birmingham,—"Improvements in the manufacture of a part or parts of railway wheels."—15th.

Richard Madigan, Haverstock Hill, Hampstead-road, Middlesex, civil engineer, and John Coope Haddan, Lincoln's-inn Fields, Middlesex, civil engineer,—"Improvements in the manufacture of wheels for railways."—15th.

Selah Hiller, New York, U. S., America,—"Improvements in the manufacture of stair-rods."—15th.

David Davies, Wigmore-street, Cavendish-square, coachmaker,—"Improvements in the construction of the heads of open and close carriages."—15th.

Charles Attwood, Esq., Woolsingham, Durham,—"An improvement or improvements in the manufacture of iron."—18th.

John Britten, Birmingham,—"Improvements in heating, lighting, ventilating, and closing and securing the doors of apartments, also in lighting and ventilating carriages, parts of which improvements are applicable to other like purposes."—20th.

Mathew Cochran, High-street, Paisley, Renfrewshire,—"Improvements in the production of coloured patterns or designs on warps of carpets, velvets, and other texile materials, parts of which improvements are also applicable to the production of coloured patterns or designs on woven fabrics or other plain surfaces."—20th.

Samuel Clegg, Regent's-square, Middlesex, engineer,—"Improvements in gas meters."—20th.

John Thang Harradine, Holywell-cum-Needingworth, Huntingdonshire, farmer,—"An improved mode of fitting certain girths and straps."—20th.

Henry Gilbert, St. Leonard's-on-Sea, Sussex, surgeon,—"An improved mode or modes of operatiug in dental surgery, and improved apparatus or instruments to he used therein." 20th.

SCOTCH PATENTS.

Sealed from 24th March, 1848, to 20th April, 1848.

Henry Newton, Litton-mill, near Bakewell, Derbyshire, spinner,—"Improvements in spinning and doubling cotton, and other fibrous substances."—March 24th.

Matthew Sproul, Liverpool, Laucashire, engineer,—"Improvemeuts in steam-engines."—April 3d.

William Sangster, Regent-street, Middlesex, umbrella and parasol manufacturer,—"Improvements in umbrellas and parasols."—4th.

William M'Lardy, Salford, Lancashire, manager,—"Improvements in machinery or apparatus applicable to the preparation aud spinning of cotton, wool, silk, flax, and other fibrous substances."—4th.

James Pedder, New Union-atreet, Middlesex, engineer,—"Improvements in steam-engines and in propelling."—6tb.

William Edward Newton, 66 Chancery-lane, Middlesex, civil engineer,—"An improvement or improvements in making coupling joints for pipes, nozzles, stop-cocks, still and cylinder heads, and other apparatus." (Communication.)—11th.

James Clegg, Regent-square, Middlesex, engineer,—"Improvements in gas meters."—11th.

David Fisher, Clerkenwell Green, Middlesex, bootmaker,—"Improvements in the manufacture of hoots and shoes."—11th.

Matthew Curtis, Manchester, machinist, and Robert Lakin, Ardwick, Lancashire, machinist,—"Improvements in machines used for preparing to be spun and spinning cottou and other fibrous substances, and for weaving such substances when spun."—17th.

Henry Heywood, Throstle Nest mills, Blackburn, Lancashire, cotton-spinner,—"Improvements in looms for weaving."—13th.

John Coates, Seedley, Lancashire, calico printer,—"Certain improvements in machinery or other apparatus for printing calicocs and other surfaces."—19tb.

James Derbam, manager of Thomas Willett and Co.'s spinning mills, Bradford, Yorkshire,—"Improvements in machinery for carding, combing, preparing and spinning eotton, wool, Alpaca, mohair, flax, silk, and other fibrous materials."—20th.

IRISH PATENTS.

Sealed from 2nd March, 1848, to 20th April, 1848.

James Combe, Belfast, engineer and mechanist,—"Improvements in machinery for hackling, or dressing flax and other fibrous substances, and in machinery for effecting the separation of the fibre from the straw of flax or hemp."—March 2d.

George H. Dodge, Attelborough, Massachusetts,—"New and useful improvements in machinery for spinning and winding yarn."—15th.

George Ambroise Michaut, Epieds, France, gentleman, now of 14, Gerard-street, Soho, Middlesex,—"Improvements in tbe production and appliеation of heat aud in the manufacture of coke."—15th.

Charles Hancock, Brompton, Middlesex, gentleman,—"Improvements in the preparation of gutta percha, and in the application thereof, alone and in combination with other materials, to manufacturing purposes."—17th.

William M'Lardy, Salford, Lancasbire, manager,—"Improvements in machinery or apparatus applicable to the preparation and spinning of cotton, wool, silk, flax, and other fibrous substances."—April 14th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from March 18th, 1848, to April 19th, 1848.

March 18th, No. 1388. William Bedington, junior, Birmingham—"Gas-burner."
20th, 1389. J. and D. Nicoll, Regent-street and Cornhill,—"Paletôt."
— 1390. John Nurse and Robert Warren, Crawford-street, Bryanston-square,—"Carriage."
21st, 1391. Blake and Parkin, Sheffield,—"Three-curved spring for railway carriages, trucks, and locomotive engines, and for all kinds of vehicles on common roads."
— 1392. Messenger and Sons, Broad-street, Birmingham,—"Bulbous Flower-glass."
— 1393. Tyler and Sons, Warwick-lane, Newgate-street,—"Soda-water machine."
22d 1394. Hugh Strath, Brownlow Mews, London,—"Wash-hand stand and basin."
— 1395. Cronin, Wbeeler, and Co., Barlett's-buildings, Holborn,—"Le cbevalier; an ornament for securing pins and brooches effeetually in the dress."
— 1396. Richard Moss, Bartbolomew-square, Old-street,—"Foot-warmer and influenza vapour bath."
— 1397. Tyler and Pace, Queen-street, Cheapside,—"Roller for Venetian blinds."
— 1398. William Marples, Spring-lane, Sheffield,—"Mortice guage."
24th, 1399. J. W. and G. Stevens, Stowmarket brewery, Stowmarket,—"Barley or grain riddling macbine."
27th, 1400. Barnabas Urry, Newport, Isle of Wight,—"Drill."
— 1401. George Jacobs, Cockspur-street,—"Handle for umbrellas and parasols."
28tb, 1402. Richard Graves, High Holborn, tailor and trousers maker,—"Waistcoat."
— 1403. Tyler and Son, Warwick-lane,—"Water-closet."
29th, 1404. William Jeakes, Great Russell-street, Bloomsbury,—"Day's Crown windguard and ventilator."
— 1405. Simcox, Pemberton and Sons, Birmingham,—"Rack-pulley."
30th, 1406. Hilliard and Thomason, Birmingham,—"Slide and spring safety brooch."
— 1407. William Preist, Strand, trunk and portmanteau manufacturer,—"Railway traveller's *vade mecum*."
April 3d, 1408. Henry Christopher Windle, and William Dunn Blyth, Walsall,—"Lock and key."
5th, 1409. Robert Wilson, Low Moor Iron-works, Yorkshire,—"Sedimeut-collector for steam boilers."
— 1410. William Wethered, King's Lynn,—"Waistcoat."
7th, 1411. Joseph Pimlott Oates, Lichfield.—"Diapbonous valve for the cornopean and other wind instruments."
8th, 1412. Francis Bassano, Birmingham,—"Signal lamp."
14th, 1413. Richard Wallis, junior, Basingstoke,—"Machine for cutting turnips and other vegetables."
— 1414. John Davis, Leadenhall-street, cutler,—"The Norman razor."
— 1415. George Graham, Leeds,—"Washing, wringing, and mangling machine."
18th, 1416. Robert Marples, Sheffield,—"Brace pad."
19th, 1417. Samuel and Thomas Carrington, Stockport —"Hat ventilator."
— 1418. C. and W. Lancaster, New Bond-street,—"Rifle barrel."
— 1419. Bryan Donkiu and Co., Grange-road, Bermondsey,—"Gas valve."

TO READERS AND CORRESPONDENTS.

Received—The Young Surveyor's Preceptor.

R. L., Leeds.—We replied to a similar question last month. We are sorry we cannot meet his views.

H. D.—Our Journal *is* published so as to be ready for delivery with the other periodicals, and is consequently dispatched some days before the last of the montb.

C. Williamson, London.—In one respect his plan would be an improvement; but when the first page is raised, the reader expects to see the plate ready for opening. The screw key was not specified by Mr. Park as an invention of his own, and may or may not have been the production of Mr. Budding. We have not attained perfection in the two points he mentions; but can he point out any similar work at all comparable to ours in these respects?

A Mechanic, London.—If the galvanic process could he cheaply and simply applied, it would remedy the objection very considerably; but is to he remembered that cheapness is indispensable.

Alpha, Macclesfield.—Wishes to know "what is the generally received opinion respecting the constitution of the atmosphere,—whether the gases composing it, are chemically or mechanically combined." Also, the "best work on the analysis of water."

Inventor.—His apparatus is very clever, and will doubtless work well. We shall he glad to hear more of it.

J. H.—The machine clearly comes within the scope of the Registration Act; he must understand that protection must he applied for previous to publication of the plan.

ANIMALCULES.

Whilst the telescope enlarges the boundary of the visible universe, and reveals the infinity, so far as human faculties are concerned, of Space, the microscope opens to us new views of organised existence, and impresses us with an idea of the variety of Life. By the one instrument we are made acquainted with the minuteness—the nothingness—of our globe, in comparison with the extent of space and the bodies which inhabit it; by the other we learn the length of that chain of organic being, at the head of which is Man. The telescope teaches us the vastness of the universe; the microscope the minuteness of its parts; and both declare to us that infinite Wisdom has gone hand in hand with infinite Power in its creation.

When Hooke first applied his newly discovered instrument to the examination of a drop of stagnant water, he found that it contained swarms of beings not previously dreamed of. Linnæus, in drawing up his "Systema Naturæ," placed these minute animals, not then sufficiently observed, at the end of the class, Worm, in a genus which he named Chaos. Müller first constituted them a distinct class, and as he had generally found them in water wherein vegetable or animal matter had been dissolved by infusion, he denominated them *Infusoria*, a name they still bear in philosophical treatises. Müller examined many species, and classified them with reference to their external form and arrangement, which has since been abandoned for one based on the internal structure of the animals. The naturalist to whom we are indebted for a truer knowledge of animalcules, is Dr. Ehrenberg of Berlin, who, in 1838, published a folio volume with sixty-four plates, containing the result of his observations, conducted with wonderful patience and sagacity, upon these marvellous creatures, for a series of years. He divided them into two classes, *Polygastria* and *Rotifera*. The former are furnished with a stomach, consisting of many cavities connected by a tubular channel; no organs of circulation, nor any nervous system, have hitherto been found in this division. They have been seen in salt water as well as fresh, in bogs and humid soil. There is great diversity in their outward conformation, but all their movements from place to place are effected by means of cilia, delicate hair-like processes distributed over the body, which in the living animal are, night and day, in perpetual motion. These are supposed to be the chief organs of touch and taste, as well as of propulsion. They are exceedingly minute, and little is known of their structure; but at the base of each there is a small bulb, conjectured to be the seat of muscles. When the water in which an animalcule is placed, is artificially coloured with carmine or indigo, the currents occasioned by the vibration of the cilia are made distinctly visible. The Rotifera, a more highly organised class, are so named from the cilia being disposed in one or more rows round the upper part of the body, and from the motion of these appendages giving the appearance of the rotation of a wheel.

In all the species, distinct digestive organs have been found. Even the smallest monads are furnished with a mouth and an internal nutritive apparatus. The alimentary canal has very different shapes. In the most highly organised tribe, a simple stomach situated in the upper part of the body, communicating with an æsophagus and intestinal canal, is the usual form. The mouth is armed with serrated mandibles, or it is a simple orifice without being armed, but in either case it is surrounded by cilia. Ehrenberg affirms that he has discovered muscles in the higher species of Infusoria in the shape of white fibres longitudinally crossing the body, which may be seen to contract and expand when the animal is in motion. In the simpler forms no such fibres have been perceived. When eyes are visible, they are spots of a red colour, two or more in number, and connected with the nervous system; but from the manner in which all Infusoria pursue and capture their prey, we may presume that they are furnished with organs of vision, even when they are not revealed by the microscope.

To pass from this general sketch of animalcular organisation to the two classes of Ehrenberg, we may notice that in both, he arranges parallel series, founded on the fact of the integuments being naked in some species, and in others coated with a horny or crustaceous covering, *nuda* and *loricata*, both species very often agreeing entirely in structure except in this particular. The class Polygastria is divided into two legions: Anentera, or animalcules having a mouth in connection with several stomachal cavities, but with no intestinal tube or separate orifice of discharge; and Enterodela, or those in which there are distinct orifices of reception and discharge, opening into an intestine in communication with the stomachs. Each of these legions is subdivided into sections, families, and genera. Instead however of entering into tedious details, we will select a genus from each legion for consideration. The Monads belong to the Anentera, and in order to distinguish them, we shall require glasses that magnify 300 or 400 times in lineal dimensions, for the largest individuals to be considered, are not more than $\frac{1}{2000}$ part of a line (the twelfth of an inch) in diameter, and a drop of water may contain five hundred millions of them. Their colours are very various—green, red, pink, yellow, blue, &c. Eyes may be seen as red specks in some, in others, no organs are visible, except the cilia and a few projections resembling spines or bristles. No alteration in form has been observed to take place in motion. Curious to relate, the mode of increase is by self-division. An individual begins to split, the fissure is soon completed, and one becomes two. At the termination of the process each part seems to be repelled from the other, and they swim off in opposite directions. Some of the Monads are always found singularly connected under a common case, either tabular (such as the Gonium) or spherical, of which the Volvox is an instance. In these we discover groups of individuals organically connected with each other and with the enclosing integument. In the Gonium, the mode of increase is this: take a group of sixteen arranged in rows of four; this splits through the middle in both directions, and thus four portions, each containing a like number of monads, is formed. Each of these portions is subdivided in the same way, and thus the animals increase by division *ad infinitum*. In the Volvox a division takes place in the interior of the case, the young animals drop into the vacant part of it, and remain there until they are further developed; part of the spherical integument then gives way, and the young effect their escape through the opening. The name of this monad is given to it from its revolving motion in the water, whereby its propulsion is effected, and this is the result of the cilia which are successantly in action, supposed to be involuntary.

In the legion of the Enterodela we will select the Vorticellina, or bell-shaped animalcules, for notice. Many of the aquatic plants of our island will be found on examination to have the stems and the under-sides of their leaves covered with a substance like mucus or jelly; and when placed under lenses of moderate power, it is seen to consist of clusters of animalcules, shaped like a funnel or bell. The upper rim is furnished with a belt of cilia, sometimes more, but they are confined to the same locality, and are not diffused, as in the monads, all over the body. One genus is named Stentor, or Trumpet animalcule, having a longish curved stem, and a large circular head, something resembling a musical instrument. The individuals have the power of fastening themselves by the lower end of the stem; they move with rapidity through the water, and are a very voracious set of creatures. They have various colours, and one species is half a line in length, and therefore quite perceptible by the naked eye. Another genus is that denominated Vorticella, comprising genera of very elegant forms. They are found clustered together on twigs and leaves under water, and they generally make their appearance in vegetable infusions. Shells of small Crustaceans are frequently spotted with them. The Vorticellæ have bell-shaped bodies with a circle of cilia on the upper margin. The edge of the cup projects a little, whilst from the bottom of it there is a delicate stalk, connecting it with a base, common to a group of individuals. The cup measures about $\frac{1}{24}$ of a line. The stalk can be acted upon in a moment by the animal,

so that what was straight or a simple curve can be contracted into a spiral tendril. The movements of a group are very curious when attentively examined. The conversion of a straight line into a spiral, may always be seen in some one individual of a cluster, and perhaps several are doing it at the same time. The whole cluster will sometimes shrink all at once into a confused mass, and immediately afterwards expand again, every cup being fully opened out with its little circle of cilia in quick motion. The Vorticellæ increase by self-division like the Monads. A split begins to divide the cup lengthwise, and when a complete division is effected, each part grows into a perfect specimen, cilia sproutiug out round the upper edge, and the connecting stalk perishes. Each part then throws out a fresh stalk, by which it is fixed to a locality, and by other splits, a new colony of individuals is quickly formed. In a genus, Carchesium, nearly allied to the preceding, there is a common stem, from the top of which a number of branches strike off, and to these the cup-shaped animals are attached. When fully expanded, the whole resembles a miniature tree. In its contracted state the stem curls up into a spiral, and the branches with their cups shrink into a ball.

In the second class, namely, the Rotifera, we find the animalcules more highly organised. The species no longer increase by fissuration or division; the digestive organs are not so numerous; and though the cilia still perform the office of propulsion, their arrangement is different. Knots of nervous fibre, called ganglia, have been seen in some of the individuals of this class. The pharynx, the narrow part of the upper portion of the alimentary canal, is usually armed with jaws, and often with teeth. In Ehrenberg's book, many jaws and teeth are figured, showing great diversity in shape; and the author says that the Rotifera might be arranged without much difficulty according to their teeth, like quadrupeds. In some species there is a pedicle or caudal appendage, by which the body can be fixed at the will of the animal whilst it is working its cilia. Apertures near the neck have been noticed, by which fresh water is constantly introduced, and something like the respiratory organs of a fish have been observed. Some kinds produce eggs, others bring forth their young alive. The sac in which the eggs are formed is plainly perceptible. Not many are developed at once, but a distended egg-sac sometimes equals one-third of the whole body in size. These eggs are extremely tenacious of the living principle. They will remain for an indefinite period undeveloped, carried here and there by wind and water, until they meet with some medium peculiarly adapted for hatching the animal. What is still more singular is, that the adult animals of some species may be dried up to apparently lifeless dust, and then, on the addition of water, they will start into an active existence again, "as if aroused from a refreshing slumber." Animalcules that had been left to dry, revived on being placed in water, no less than twelve times; and Professor Owen tells us that he has seen the resuscitation of an animalcule which had been kept in dry sand for four years!

As examples of the present class, we may refer to the Floscularia, a genus which belongs to the loricated series. The body is inclosed by a tubular sheath, which is open at the upper end, so as to allow the animal to protrude the upper part of its body, in which state the whole wears a flower-like appearance—whence the name. The lower end of the case is fixed to some other object. When the water is agitated, the animal withdraws its head into its sheath. The Limnias and the Melicerta belong to this family; both have eyes when young, which they lose as they grow older. Other species of Floscularia have perfectly transparent cases, which permit the internal organs to be examined. The cilia are long and delicate threads, with which they hunt for and envelope their prey. Almost the whole body can be pushed out of the sheath, and eggs can frequently be perceived within it, beside the stalk. Another beautiful family is the Stephanoceros, generally found attached to the leaves of the water-lily and other aquatic plants. The case is a transparent tube, and the animal consists of a stalk, which swells at the upper end into a bulb, and from the top of this proceed five long arms, which, when drawn into the tube, lie side by side, but when projecting at the top, retreat from one another, and meet again at their points, so as to form an elongated dome, the base of which surrounds the mouth.

To the genus Philodinœa belongs the common wheel animalcule *(Rotifer vulgaris)*, described as early as 1702 by Leeuwenhoek. It is an abundant creature, and may be met with in every pool of water. When largest, it measures about half a line; its colour is whitish, its shape is not unlike a fish, broadest in the middle and tapering to each end. At the upper extremity are the wheel-like cilia, the eyes, and mouth. The animal is oviparous, and produces eggs in such enormous numbers that, by the tenth day, Ehrenberg calculated ten millions will proceed from a single individual.

An examination of various strata of the globe has brought to light the fact, that there are immense numbers of fossil animalcules in the crust of the earth. The cases or shells of the loricated Infusoria contain lime, silex, or iron, and when these are shed by the countless tribes which inhabit bodies of water, an accumulation of matter soon forms, which undergoes the same process as other deposits. Entire chains of hills have thus been occasioned. The white earthy substance to be found in peat-bogs consists of the shells of infusoria, and so is the marly paste of swamps. The remains of minute infusory animals constitute almost entirely the slaty tripoli of commerce, and the polishing slate of Bilin in Bohemia, which is fourteen feet thick. A cubic inch of it contains forty-one thousand millions of shells. In America there are extensive beds of marl composed of fossil animalcules. Siliceous rock from the Isle of France has been found to consist nearly altogether of animalcules belonging to living species; and guano from Ichaboe has also disclosed fossils of great beauty. It is thus evident that these little beings have played no unimportant part in the history of the globe's crust; and we may conjecture, with every appearance of reason, that their dead forms are at this day slowly adding to the materials which at some future period will constitute new strata for the examination of geologists yet unborn.

REPORT OF EXPERIMENTAL INVESTIGATIONS ON COALS, FOR THE STEAM NAVY.

By Sir H. De La Beche and Dr. Lyon Playfair.

With regard to the selection of the coals for trial, we have to refer to Mr. Wilson's letter, inserted in the Appendix. This letter gives the information obtained in a tour made by Professor Wilson for the purpose of ascertaining the best coals fitted for trial in the South Wales coal district, and the ports from which they can conveniently be shipped. This district was selected because the varying character of the coals, from the bituminous to the anthracitic, offered those which were most likely to combine the qualities desired for naval purposes. It was intended, as being most convenient for the inquiry, to have adhered strictly to districts. In the experiments this has hitherto been done, except in special cases, at the request of the Admiralty.

Table II. contains an abstract of the results, so far as regards the evaporative value of the fuel; the special characters of each of the coals being described in the experiments detailed in the Appendix.

This table relates only to the economical value of the coals examined, and to the steam generated by a unit of the respective coals, without, however, implying a unit of time. The details with reference to time, which forms a most important element in the value of the respective fuels, will be found in section II.

The economical results obtained by evaporatiou, in the best applied practice, are ascertained to be only a small part of the theoretical result following from the actual quantity of heat capable of being generated. Still, as a comparative statement, it is necessary to contrast the economical heat given out by a coal with the theoretical quantity. The cause of the difference between the applied and theoretical quantities is, at least in a great degree, obvious, and does not by the apparent difference prove the fallacy of calculation. Before the comparison can be made, it is necessary to have a knowledge of the composition of the respective coals; of this we subjoin a table, reduced from section IV.

Chemists differ as to the mode of calculating the theoretical heating values of coals, but, as an approximative rule, without insisting on its absolute accuracy, their calorific values are found to stand in relation to the quantity of oxygen required for their complete combustion. This

may be estimated experimentally by heating the coal with an excess of litharge, in the manner and with the precautions described by Mr. Philips, or it may be determined by calculation from the known equivalents of the combustible ingredients of the coal. From the quantity of lead reduced by the coal, the oxygen employed in its combustion may be estimated, and the calorific values stand in direct relation to this quantity. The amount of oxygen necessary to consume the combustible constituents may more accurately be determined by elementary analysis; and thus calculated, the results are generally found to be about one-ninth greater than those indicated by experiment with the litharge. The calculation from the elementary analysis depends upon the circumstance, that 6 parts, or one equivalent of carbon, requires 16 parts, or two equivalents of oxygen for combustion, while 1 part of hydrogen requires 8 parts of oxygen; it is only necessary, therefore, to subtract from the hydrogen a quantity corresponding to the oxygen contained in the coal, to enable the calculation to be made on these principles.

TABLE II.—*Showing the Economic Values of the Coals.*

Names of Coals employed in the Experiments.	Economic evaporative power, or number of pounds of Water evaporated from 212° by 1 lb. of Coal.	Weight of 1 cubic foot of the Coal as used for fuel	Weight of 1 cubic foot reduced from the density.	Ratio of B to C, or of the economical to the theoretical weight.	Difference per cent. between theoretical and economical weights.	Space occupied by 1 ton in cubic feet (economic weight).	Results of experiments on cohesive power of Coals per centage of large Coals.	Evaporating power of the Coal after deducting for the combustible matter in the residue.	Weight of Water evaporated from 212° by 1 cubic foot of Coal.	Rate of evaporation, or number of lbs. of Water evaporated per hour.
		lbs.	lbs.							Mean.
	A.	B.	C.	D.	E.	F.	G.	H.	I.	
WELSH COALS:—										
Graigola	9·35	60·166	81·107	·742	34·8	37·23	49·3	9·66	581·20	441·48
Anthracite, Jones & Co.	9·46	58·25	85·786	·679	47·26	38·45	68·5	9·7	565·02	409·37
Old Castle Fiery Vein	8·94	50·916	80·42	·633	57·940	43·99	57·7	...	455·18	464·30
Ward's Fiery Vein	9·40	57·433	83·85	·685	46·	39·	46·5	10·6	608·78	529·90
Binea	9·94	57·08	81·357	·702	42·53	39·24	51·2	10·3	587·92	486·95
Llangennech	8·86	56·93	81·85	·695	43·76	39·34	53·5	9·2	523·75	373 22
Pentrepoth	8·72	57·72	81·73	·705	40·17	38·80	46·5	8·98	518·32	381·50
Pentrefelin	6·36	66·166	84·726	·781	28·051	33·85	52·7	7·4	489·62	247·24
Duffryn	10·14	53·22	82·72	·643	55·43	42·09	56·2	11·80	540·12	409·32
Mynydd Newydd	9·52	56·33	81·73	·689	45·09	39·76	53·7	10·59	536·26	470·69
Three-quarter Rock Vein	8·84	56·388	83·60	·674	48·26	39·72	52·7	...	498·46	486·86
Cwm Frood Rock Vein	8·70	55·277	78·299	·706	41·648	40·52	72·5	9·35	480·90	379·80
Cwm Nanty-gros	8·42	56·0	79·859	·701	42·60	40·00	55·7	8·82	471·52	404·18
Resolven	9·53	58·66	82·354	·712	40·39	38·19	35·0	10·44	559·02	390·25
Pontypool	7·47	55·7	82·35	·676	47·845	40·216	57·5	8·04	416·07	250·40
Bedwas	9·79	50·5	82·6	·611	63·565	44·32	54·0	9·99	494·39	476·96
Ebbw Vale	10·21	53·3	78·81	·676	45·98	42·26	45·0	10·64	544·19	460·22
Porth-mawr	7·53	53·3	86·722	·614	62·7	42·02	62·0	7·75	401 34	347·44
Coleshill	8·0	53·0	80·483	·658	51·85	42·26	62·	8·34	424·0	406·41
SCOTCH COALS:—										
Dalkeith Jewel Seam	7·08	49·8	79·672	·625	59·984	44·98	85·7	7·10	352·58	355·18
" Coronation Seam	7·71	51·66	78·611	·657	52·17	43·36	88·2	7·86	398·29	370·08
Wallsend Elgin	8·46	54·6	78·611	·694	43·78	41·02	64·	8·67	460·82	425·77
Fordel Splint	7·56	55·0	78·611	·699	42·92	40·72	63·	7·69	415·80	434·98
Grangemouth	7·40	54·25	80·48	·674	48·35	40·13	60·7	7·91	401·45	380·40
ENGLISH COALS:—										
Broomhill	7·3	52·5	77·988	·673	48·55	42·67	65·7	7·66	383·25	397·78
Lydney (Forest of Dean)	8·52	54·444	80·046	·68	47·02	41·14	55·0	8·98	463·86	487·19
IRISH COAL:—										
Slievardagh Anthracite	9·85	62·8	99·57	·630	58·55	35·66	74·	10·49	618·58	473·18
PATENT COALS:—										
Wylam's Patent Fuel	8·92	65·08	68·629	·948	5·45	34·41	...	9·74	630·51	418·89
Bell's "	8·53	65·3	71·124	·918	8·91	34·30	...	8·65	557·0	549·11
Warlich's "	10·36	69·05	72·248	·955	4·49	32·44	...	10·60	715·35	457·84

As the calorific values are only relative, it is useful to refer them to the heating power of pure carbon, 1 part of which requires 2·666 parts of oxygen for combustion, and is capable, according to Despretz, of heating 78·15 parts of water from its freezing to its boiling point. The calculation may be simplified by multiplying each part of lead obtained, by 2·265, which gives at once the weight of water capable of being heated between these temperatures by a unit of the coal used in reducing the litharge. On these principles the following table is constructed— (*See* Table IV.)

With regard to the practical application of fuel, such a Table could not supersede experiment, as the economical values of the coal depend also on adventitious circumstances connected with their physical as well as their chemical condition. This Table, while on the whole it agrees with and confirms the practical results of experiments, still differs in a marked degree in one or two instances: this difference arising as much from the chemical as from the physical differences of the coals. Thus, if by destructive distillation, which occurs in furnaces before combustion, a large quantity of the constituents of the coal are rendered gaseous, so much heat is expended in this act that the heat developed by their after combustion is frequently not greater than that abstracted during their formation, in which case a thermo-neutrality occurs. To ascertain the proportion of fixed and volatile products in the various coals, the very difficult and elaborate process described in section IV. page 55, was adopted; but the tediousness and chances of failure in this kind of analysis have only induced us to include a limited number of coals (those given in Table V.), especially as for steam purposes it was sufficient to determine the per centage of coke, as stated in Table II.

TABLE III.—*Showing the Mean Composition of Average Samples of the Coals.*

Locality or name of Coal.	Specific Gravity of Coals.	Carbon.	Hydrogen.	Nitrogen.	Sulphur.	Oxygen.	Ash.	Per centage of Coke left by each Coal.
WELSH COALS:—								
Graigola	1·30	84·87	3·34	0·41	0·45	7·19	3·24	85·5
Anthracite	1·375	91·44	3·46	0·21	0·79	2·58	1·52	92·9
Oldcastle Fiery Vein	1·289	87·68	4·89	1·31	0·09	3 39	2·64	79·8
Ward's Fiery Vein	1·344	87·87	3·93	2·02	0·83	Included in ash.	7·04	...
Binea Coal	1·304	88·66	4·63	1·43	0·33	1·03	3·96	88·10
Llangennech	1·312	85·46	4·20	1·07	0·29	2·44	6·54	83·69
Pentrepoth	1·31	88·72	4·50	0·13	...	3·24	3·36	82 5
Pentrefelin	1·358	85 52	3·72	Trace.	0·12	4·55	6·09	85·0
Duffryn	1·326	88·26	4·66	1·45	1·77	0·60	3·26	84·3
Mynydd Newydd	1·31	84·71	5·76	1·56	1·21	3·52	3·24	74·8
Three-quarter Rock Vn.	1·34	75·15	4·93	1·07	2·85	5·04	10·96	62·5
Cwm Frood Rock Vein.	1·255	82·25	5·84	1·11	1·22	3·58	6·00	68·3
Cwm Nanty-gros	1·28	78·36	5·59	1·86	3·01	5·58	5·60	65·6
Resolven	1·32	79·33	4·75	1·38	5·07	Included in ash.	9·41	83·9
Pontypool	1·32	80·70	5·66	1·35	2·39	4·38	5·52	64·8
Bedwas	1·32	80·61	6·01	1·44	3·50	1·50	6·94	71·7
Ebbw Vale	1·275	89·78	5·15	2·16	1·02	0·39	1·50	77·5
Porth-mawr Rock Vein.	1·39	74·70	4·79	1·23	0·91	3·60	14·72	63·1
Coleshill	1·29	73·84	5·14	1·47	2·34	8·29	8·92	56·0
SCOTCH COALS:—								
Dalkeith Jewel Seam	1·277	74·55	5·14	0·10	0·33	15·51	4·37	49·3
" Coronation Seam	1·316	76·94	5·20	Trace.	0·38	14·37	3·10	53·5
Wallsend Elgin	1·20	76·09	5·22	1·41	1·53	5·05	10·70	58·45
Fordel Splint	1·25	79·58	5·50	1·13	1·46	8·33	4·00	52·03
Grangemouth	1·29	79·85	5·28	1·35	1·42	8·58	3·52	56·6
ENGLISH COALS:—								
Broomhill	1·25	81·70	6·17	1·84	2·85	4·37	3·07	59·2
Park End, Lydney	1·283	73·52	5·69	2·04	2·27	6·48	10·00	57·8
IRISH COALS:—								
Slievardagh	1·59	80·03	2·30	0·23	6·76	Included in ash.	10·80	90·1
FOREIGN COALS:—								
Formosa Island	1·24	78·26	5·70	0·61	0·49	10·95	3·96	...
Borneo (Labuan kind)	1·28	64·52	4·74	0·80	1·45	20·75	7·74	...
" 3 feet seam	1·37	54·31	5·03	0·98	1·14	24·22	14·32	...
" 11 feet seam	1·21	70·33	5·41	0·67	1·17	19·19	3·23	...
PATENT FUEL:—								
Wylam's Patent Fuel	1·10	79·91	5·69	1·68	1·25	6·63	4·84	65·8
Bell's "	1·14	87·88	5·22	0·81	0·71	0·42	4·96	71·7
Warlich's "	1·15	90·02	5·56	Trace.	1·62	Included in ash.	2·91	85·1

It has been for some time asserted, that the evaporative value of a bituminous coal is expressed by the evaporative value of its coke, the heat of combustion of its volatile products proving in practice little more than that necessary to volatilize them. If this supposition were even near the truth, the most useful practical results might follow from it. By a larger and better applied system of gas manufacture, the volatile products of distillation might be made useful not only for the purposes of illumination, but also for domestic heat, and the residual coke might be used with an equal economy in our manufactures;* thus preventing the emission of that smoke, which, at present, is so destructive to the comfort of our large cities. It is easy from analysis to examine whether the duty performed by the coal is to be attributed to its fixed ingredients or coke, by estimating the work which the latter is capable of performing. This may be done by subtracting the amount of ashes in the coal from its amount of coke, (Table III.) and estimating the remainder as carbon. This carbon multiplied by its heating power, 13268, and divided by 965·7 or the latent heat of steam, indicates the number of pounds of water which the coke by itself could evaporate, without the aid of the combustible volatile ingredients of the coal. These results are placed in column B. of Table VI., in juxtaposition with the actual work done by the coal, and it will be seen that, notwithstanding several striking exceptions, which might have been expected, they on the whole show that the work capable of being performed by the coke alone, is actually greater than that obtained by experiments with the original coal.

The whole system of manufacturing coke is at present very imperfect. Besides losing the volatile combustible substances, which under new adjustments might be made of much value, an immense quantity of ammonia is lost by being thrown into the atmosphere. Ammonia and its salts are daily becoming more valuable to agriculture, and it is their comparative high price alone which prevents their universal use to all kinds of cereal cultivation. By a construction of the most simple kind,

* In this case it would be necessary not to carry on the process of distillation so far as at present, as the residual coke would be more combustible and the gases purer.

the coke ovens now in use might be made to economise much of its nitrogen which invariably escapes in the form of ammonia. As an inducement to this economy, we have appended to Table VI. two columns (H. and I.), showing the quantity of ammonia (NH_3) and its corresponding quantity of commercial sulphate (NH_4O, SO_3) which each 100 lbs. of the respective coals may be made to produce. When it is remembered, that the price of sulphate of ammonia is about £13 per ton, or that 100 tons in coking is capable of producing, on an average, about 6 tons of this salt, its neglect is highly reprehensible.

TABLE IV.—*Showing the Calorific Values of the Coals.*

Name of Coal.	Quantity of Lead reduced by one part of Coal.	Oxygen removed from Litharge by one part of Coal.	Quantity of Oxygen theoretically required by Carbon and Hydrogen.	Quantity of Oxygen required by Carbon alone.	Relative calorific Values, Carbon taken as 100, calculated from A. and B.	Number of lbs. of Water which 1 lb. of Coal can raise from 32° Fahr. to 212° Fahr. calculated from A.
WELSH COALS:—	A.	B.	C.	D.	E.	F.
Graigola	32·08	2·49	2·49	2·26	93·4	72·66
Anthracite (Jones and Aubrey)	33·48	2·60	2·69	2·43	97·5	75·73
Oldcastle Fiery Vein	31·42	2·44	2·71	2·34	91·5	71·16
Ward's Fiery Vein	31·46	2·44	2·65	2·34	91·5	71·25
Binea Coal	31·64	2·46	2·72	2·36	92·2	71·66
Llangennech	32·66	2·53	2·59	2·28	94·9	73·97
Pentrepoth	31·16	2·39	2·69	2·36	89·6	70·57
Pentrefelin	30·52	2·37	2·53	2·28	89·2	69·13
Powel's Duffryn	30·00	2·33	2·71	2·35	87·7	67·95
Mynydd Newydd	30·34	2·35	2·67	2·25	88·5	68·72
Three-quarter Rock Vein	26·62	2·06	2·34	2·00	77·2	60·29
Cwm Frood Rock Vein	28·30	2·19	2·62	2·19	82·5	64·10
Cwm Nanty-gros	29·64	2·28	2·47	2·08	85·5	67·13
Resolven	32·16	2·50	2·49	2·11	93·7	72·84
Pontypool	27·46	2·13	2·55	2·15	80·2	62·19
Bedwas	28·20	2·19	2·60	2·15	82·1	63·87
Ebbw Vale	32·00	2·48	2·80	2·39	93·0	72·48
Porthmawr Rock Vein	24·78	1·92	2·33	1·99	72·0	56·12
Coleshill	26·14	2·03	2·28	1·96	76·1	59·21
SCOTCH COALS:—						
Dalkeith Jewel Seam	26·42	2·05	2·24	1·98	76·8	59·84
" Coronation Seam	24·56	1·96	2·32	2·05	73·5	55·63
Elgin Wallsend	29·06	2·25	2·38	2·02	84·7	65·82
Fordel Splint	29·00	2·25	2·47	2·12	84·7	65·68
Grangemouth	28·48	2·20	2·46	2·13	82·8	64·51
ENGLISH COALS:—						
Broomhill	25·32	1·96	2·63	2·18	73·5	57·35
IRISH COALS:—						
Slievardagh	30·10	2·33	2·31	2·13	87·7	70·44
PATENT FUELS:—						
Wylam's Patent Fuel	28·82	2·23	2·52	2·13	84·0	65·27
Bell's "	28·52	2·21	2·75	2·34	83·2	64·59
Warlich's "	31·50	2·44	2·84	2·40	91·5	71·35

TABLE V.—*Showing the Amount of various Substances produced by the destructive Distillation of certain Coals.*

Name.	Coke.	Tar.	Water.	Ammonia.	Carbonic Acid.	Sulph Hydrogen.	Olefiant Gas and Hydro-Carbon.	Other Gases inflammable.
WELSH COALS:—								
Graigola	85·5	1·2	3·1	0·17	2·79	Traces	0·23	7·01
Anthracite, (Jones, Aubrey, & Co.)	92·9	None.	2·87	0·20	0·06	0·04	?	3·93
Oldcastle Fiery Vein	79·8	5·86	3·39	0·35	0·44	0·12	0·27	9·77
Ward's Fiery Vein	...	1·80	3·01	0·24	1·80	0·21	0·21	...
Binea	88·10	2·08	3·58	0·08	1·68	0·09	0·31	4·08
Llangennech	83·69	1·22	4·07	0·08	3·21	0·02	0·43	7·28

By the preceding data, the actual value of the coals will be contrasted with that which is theoretically possible, supposing their combustion proceeded under circumstances which prevented any loss of heat. The actual duty obtained by a pound of coal from the boiler employed, may be easily expressed by the number of pounds raised to the height of one foot. This result may readily be obtained by the simple formula—

$$W\ \eta \times 965{\cdot}7 \times 782 = x,$$

W representing water, of which η pounds are evaporated by a pound of coal. This formula is deduced from the fact η pounds of water multiplied by 965·7,* or the coefficient for the latent heat of steam at 212°, indicates the number of pounds of water which would be raised 1° Fahr.; and the number 782 arises from experiment on the mechanical force denoted by the elevation of a pound of water 1° Fahr.; that force being equal to 782 lbs., raised to the height of one foot, according to the careful experiments of Mr. Joule, on the friction of oil, water, and mercury.

The theoretical value of the coals, with reference to the number of pounds of water which one pound of fuel will convert into steam, is obtained by the formula—

$$\left(\frac{C \times 13268}{965{\cdot}7}\right) + \left(\frac{H - h \times 62470}{965{\cdot}7}\right) = x$$

in which C is the quantity of carbon, H the quantity of hydrogen in a unit of fuel, and h the quantity of hydrogen corresponding to the oxygen contained in the coal. These multiplied by their heating powers, according to the results of Dulong, and divided by the latent heat of steam, indicate the number of pounds of water that can be converted into the latter by a pound of coal. The numbers thus obtained can be changed into the expression of mechanical force, by the previous formulæ.

TABLE VI.—*Showing the Actual Duty, and that which is theoretically possible, of the Coals examined.*

Name or Locality of Coal.	Actual number of lbs. of Water convertible into Steam by 1 lb. of Coal —Practical.	Number of lbs of Water convertible into Steam by the Coke left by the Coal —Theoretical.	Number of lbs of Water convertible into Steam by the Carbon of the Coal —Theoretical.	Number of lbs of Water convertible into Steam by the Hydrogen of the Coal—Theoretical	Total number of lbs of Water convertible into Steam by 1 lb. of Coal —Theoretical.	Actual force generated, or the number of lbs. raised by 1 lb. of Coal could raise 1 lb. 1 foot.—Calculated from heat obtained.	Force capable of being generated, or number of lbs. which could be raised to the height of 1 foot, by 1 lb. of Coal.—Theoretical.	Amount of Ammonia corresponding to the Nitrogen contained in Coal	Amount of Sulphate of Ammonia corresponding to the Nitrogen contained in Coal.
	A.	B.	C.	D.	E.	F.	G.	H.	I.
Graigola	9·35	11·301	11·660	1·902	13·563	7·060·908	10·242·471	0·497	1·932
Anthracite, Jones & Co.	9·46	12·554	12·563	2·030	14·593	7·143·978	11·020·303	0·225	0·990
Oldcastle Fiery Vein	8·94	10·601	12·046	2·890	14·936	3·751·285	11·279·329	1·590	6·175
Ward's Fiery Vein	9·40	...	12·072	2·542	14·614	7·098·667	11·036·162	1·238	4·808
Binea	9·94	11·560	12·181	2·912	15·093	7·506·467	11·397·892	1·586	6·741
Llangennech	8·86	10·599	11·741	2·519	14·260	3·690·871	10·768·829	1·299	5·044
Pentrepoth	8·72	10·873	12·189	2·649	14 838	3·585·146	11·205·322	0·218	0·848
Pentrefelin	6·36	10·841	11·749	2·038	13·787	4·802·928	10·411·630	Trace	...
Powel's Duffryn	10·149	11·134	12·126	2·966	15·092	7·664·295	11·397·137	1·76	6·835
Mynydd Newydd	9·52	9·831	11·463	3·441	14·904	7·189·288	11·255·163	1·808	7·340
Three-quarter Rock Vn.	8·84	7·081	10·325	2·781	13·106	3·675·768	9·897·355	1·299	5·044
Cwm Frood Rock Vein.	8·70	8·628	11·300	3·488	14·788	6·570·043	11·167·563	1·347	5 232
Cwm Nanty-gros	8·42	8·243	10·767	3·165	13·932	6·358·593	10·521·131	1·919	7·448
Resolven	9·53	10·234	10·899	3·072	13·971	7·196·840	10·550·583	1·675	6·505
Pontypool	7·47	8·144	11·088	3·207	14·295	5·641·175	10·795·260	1·639	6·364
Bedwas	9·79	8·897	11·075	3·760	14·841	7·393·186	11·207·587	1·748	6·788
Ebbw Vale	10·21	10·441	12·335	3·300	15·635	7·710·361	11·025·198	2·622	10·182
Porthmawr Rock Vein	7·53	6·647	10·263	2·548	12·811	5·686·485	9·674·577	1·554	6·033
Coleshill	8·0	6·468	10·145	2·654	12·799	6·041·419	9·665·515	1·785	6·930
Dalkeith Jewel Seam	7·08	6·239	10·242	2·071	12·313	5·346·655	9·298·499	1·214	0·471
Dalkeith Coronation	7·71	6·924	10·570	2·203	12·772	5·822·417	9·645·125	Trace.	...
Wallsend Elgin	8·46	6·560	10·454	2·968	13·422	6·388·800	10·135·991	1·712	6·647
Fordel Splint	7·56	6·560	10·933	2·884	13·817	5·709·141	10·434·286	1·372	5·327
Grangemouth	7·40	7·292	10·970	2·722	13·692	5·588·312	10·339·888	1·639	6·364
Broomhill	7 30	7·711	11·225	3·638	14·863	5·512·795	11·224·201	2·234	8·674
Park End, Lydney	8·52	6·567	10·101	3·156	13·257	6·434·111	10·011·386	1·477	9·617
Slievardagh (Irish)	9·85	10·825	10·995	1·487	12·482	7·438·497	9·426·124	0·279	1·084
Formosa Island	...	...	10·752	2·801	13·553	...	10·234·919	0·777	3·017
Borneo (Labuan kind)	...	...	8·864	1·388	10·252	...	7·742·078	0·977	3·771
" 3 feet seam	...	...	7·461	1·295	8·756	...	6·612·333	1·132	4·620
" 11 "	...	...	9·652	1·948	11·600	...	8·764·057	0·813	3·158
Wylam's Patent Fuel	8·92	8·378	11·186	3·145	14·331	7·736·182	10·822·447	2·040	7·920
Warlich's "	10·36	11·292	12·368	3·596	15·964	7·823·63	12·055·652	Trace.	...
Bell's "	8·53	9·168	12·074	3·343	15·417	3·441·663	11·642·569	0·983	3·818

The results of these calculations are thrown into Table VI.

SELF-ACTING BREAK FOR RAILWAY CARRIAGES.

By GEORGE STEPHENSON, Esq., TAPTON HOUSE, CHESTERFIELD.

This simple contrivance is one of the few practicable schemes which the accumulative mass of casualties has forced upon the attention of the directing heads of the iron ways. The lengthy discussions which the subject has occasioned, hardly leaves room for further observations as to the plans which offer most security to the traveller; but it may be remarked that whatever mechanical combinations may be brought into play, there must always be loopholes for the passage of accident, and nothing can compensate for a want of due attention on the part of the conductors of the machinery

It would not be a very difficult matter to construct an apparatus which, theoretically and on paper, would divest a railway of every chance of going wrong. Upon such an arrangement, then, the officials rely for safety, and the probable result is a series of accidents, which ordinary attention to the details of simpler matters would have entirely prevented.

Mr. Stephenson, who, as the father of railways, appears ever mindful of his progeny, has not forgotten the essential requisite of simplicity, and the automatic break he proposes is perhaps less complex than the ordinary hand breaks at present in use. Our engravings, which are from accurate drawings of Mr. Stephenson's original design, exhibit,

* The coefficient for the latent heat of steam at 212° is generally taken at 1000°, but the above number is from the recent experiments of Regnault on this subject, as given in Table I.

Fig. 1.

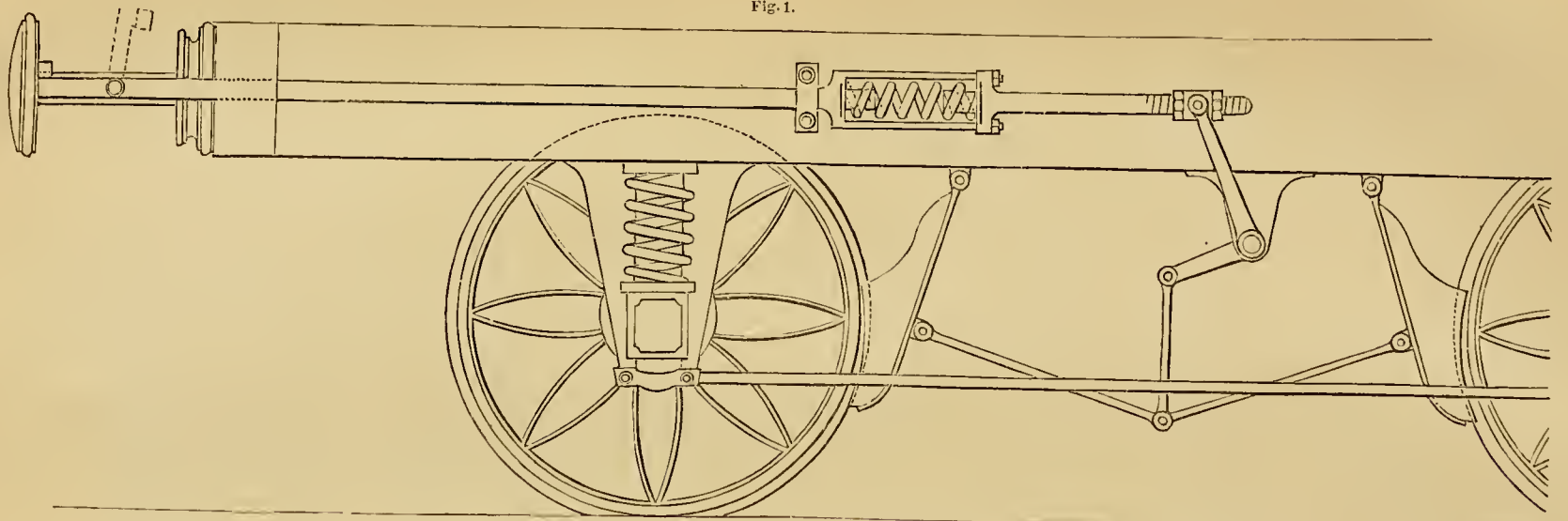
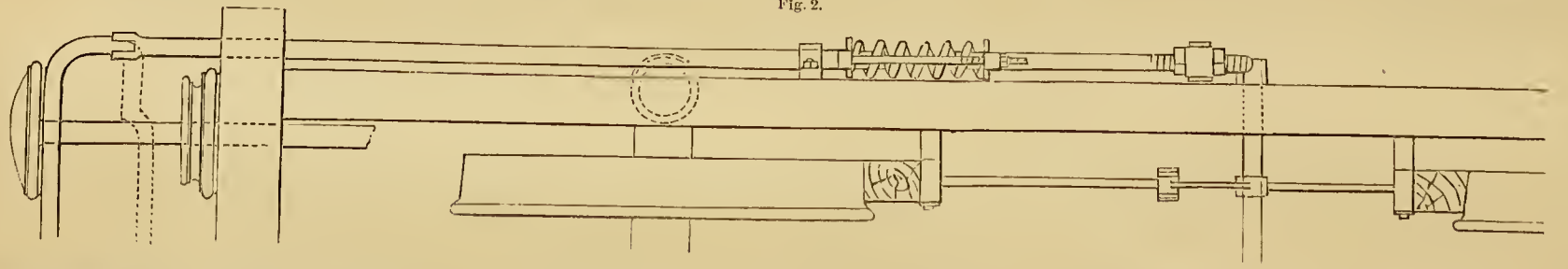


Fig. 2.



in fig. 1, a side elevation of the break as applied to the frame of a railway truck. Fig. 2 is a plan of the same.

The species of break to which Mr. Stephenson has adapted his self-acting apparatus is the ordinary one with the friction-blocks connected by knee-jointed links. The horizontal shaft working the knee action, carries a short lever at each extremity, placed just outside the truck frame. This lever is fitted by a double eye to an adjustable stud collar on the end of the actuating rod, communicating with the buffers; it is T headed, and drilled to receive the forked ends of a second rod, working through the end frame of the truck, and guided by an eye screwed to the side frame. A spiral spring is fitted to work within these forks, being guided by central projections passing into the interior of its coils. The two spring rods are hinged to a transverse bar running across the framing, just within the buffers, with which it comes in contact when laid down for action. The working of this break is best explained in Mr. Stephenson's own words:—

"When a railway train is moving at the rate of from 40 to 60 miles an hour, the momentum is so great, that it cannot be stopped in any reasonable distance by the breaks at present in use; or if an axle-tree breaks, or any accident happens to the engine, so as to prevent its progressing, the sudden shock causes the carriages to over-run each other, and those next the engine are almost certain to be crushed. In an accident of this kind, neither the stoker, engine-driver, or guard can be prepared; and before there is time for any of them to put on the break at present in use, so as to be in the least degree effective, the collision or concussion takes place. When the engine-driver shuts off the steam, or applies his break on the tender, the self-acting break is immediately brought to bear upon every wheel attached to every carriage in the train so powerfully, if necessary, as to bring every wheel into the condition of a sledge. I think the train will be brought to a stand by this break in one-tenth of the space in which it can be by the breaks at present used."

As the cross bar of the break-rods is in immediate contact with the back of the buffer-plate, it is plain that the moment any pressure comes upon the end of the buffers, by the momentum of the train acting upon the engine when its speed is diminished by shutting off the steam, each of the break-blocks will be put down upon the wheels by the spring-rods and levers forming the connection with the buffers. By the arrangement of the spring, any amount of tension may be given to it, so as to cause the pressure to act more or less intensely upon the breaks. The dotted portions in our engravings show the plan of throwing the apparatus out of action, when it is intended to back the train. This is effected simply by raising up the hinged cross-bar so as to be out of connection with the buffers, as shown in the elevation, fig. 1. The position of the suspending stud of the break blocks causes the latter to come clear of the wheel immediately that the pressure is removed from them.

ANATOMY OF THE PHYSICAL STRUCTURE OF THE UNIVERSE.

By Mr. R. Smith, Blackford.

I.—Electricity.

With the flight of each succeeding age, the curiosity of man appears to increase—his desire to know more of himself and the objects that surround him, gradually expands—and his minute endeavours, steadily held on, lay open to him, step by step, a portion at least of the mysteries of mind and matter. Aided by the light handed down to him by his predecessors, his researches in the unexplored regions of the material world explain away the superstitious falsities of ignorance, and account for phenomena previously deemed too profound for mortal ken. In contemplating the minutiæ of the globe, he finds that a grain of sand, a drop of water, and the petals of a flower, are in themselves worlds teeming with animal creations—and that a few simple bodies combined in different proportions are sufficient to produce the infinity of subjects of the animal, vegetable, and mineral kingdoms.

Chemical analysis shows us that when man dies, his mortal remains forthwith become agents in the production of the ever-changing series of animate and inanimate matter. Hence, the elementary constituents of our bodies have probably performed their part in the bodies of past generations, and will undoubtedly enter into those of generations yet to come.

The oxide or rust on the surface of iron being decomposed, the liberated oxygen perhaps lends its aid to the blooming daisy of the meadows, or it may be that it becomes a leading constituent of the vital portions of a human being. Numerous apparent anomalies might be adduced to illustrate the variety of the applications of matter, and the peculiar results obtained by different combinations. Side by side, upon the same soil, we find the most nutritious and most poisonous plants: take, for instance, the turnip and the Conium Maculatum, or common hemlock. The first of these is one of the most useful and valuable of the productions of the fields; the second is a violent narcotic poison, which, when taken internally, or applied to a wound, brings on stupor, intoxication, convulsions, and death. Still the ultimate elements of both are identical, but compounded in different proportions.

If we heat iron and sulphur together, the result will be a yellow metallic mass, possessing properties very different to those of either of the two simple bodies. Muriate of lime in solution and sulphuric acid, poured together, produce a solid substance—plaster of Paris—although both the component liquids are limpid and colourless. A mixture of a solution of caustic soda and hydro-chloric acid, both very powerful poisons, produces that essence of usefulness, common salt; and by certain chemical processes, all or any of these substances may be again reduced to their fundamental matters unaltered and undiminished.

Had the universe contained one kind of matter only, mechanical philosophy would have sufficed to explain all phenomena; but, instead of one, we have fifty-six, each of which, so far as the limits of our present information extend, appear to be essentially different. An acquaintance with chemical science enables us to imitate the various members of the mineral kingdom, by compounding their elementary constituents. Thus, if a current of carbonic acid gas is transmitted through lime water, carbonate of lime will be precipitated. With organic bodies the case is different, for no cunning of man can combine the elements of vegetable matter, as oxygen, hydrogen, nitrogen, and carbon, so as to form an organized structure. As well might he attempt to give a sweeter fragrance to the rose, or dye the blushing tints of the violet a brighter hue.

With the assistance of electro-chemistry, we penetrate still deeper into the mazes of unexplained phenomena. When a current of electricity traverses substances of feeble conducting power, decomposition takes place. In 1800, Messrs. Nicholson & Carlisle showed that water might be thus decomposed by the voltaic pile. To Sir H. Davy we are indebted for the grand law of the chemical effects of electricity, as given in his celebrated Bakerian Lecture. The principles laid down by this eminent authority are to the effect that acids, oxygen, chlorine, fluorine, iodine, and bromine, are resolved to the positive pole of the battery; and inflammable bodies, earths, alkalis, metals, and oxides, to the negative pole. The term pole is given to the ends of the wires proceeding from the battery, from a belief that they are possessed of attractive and repulsive forces, like the poles of a magnet, which they exert towards the elements of the decomposing substance. Dr. Faraday denies the existence of such forces, and asserts that the poles act only as doors or pathways for the current; he has therefore substituted the term *electrodes* for positive and negative, meaning the conductors which serve to convey the electric current into the decomposing substance. The point where the current enters the decomposing substance he names *anode*, from the Greek word signifying upwards, or the way in which the sun rises. The point where the current issues from the decomposing substance he calls the *cathode*, downwards, arguing that electricity follows the course of the sun. Decomposition he terms *electrolyzation*, and all substances capable of decomposition by the voltaic pile, he calls *electrolytes*. The elements of an electrolyte are *ions*, and the *anions* are the ions which appear at the anode, such as oxygen, iodine, &c.; whilst *cations* are the ions which appear at the cathode, as alkalis and metals. This classification is excellently adapted for the illustration of electro-chemistry, but tends to confusion in the other branches of the science, insomuch that great inconvenience results from a want of a generalized system applicable to each department.

According to Du Fay, all unexcited bodies contain two distinct electric fluids, equally subtle, elastic, and diffusive; the one is produced by the friction of glass and woollen cloth, the other from wax similarly excited. Hence the former has obtained the name of vitreous, and the latter that of resinous, electricity. Many objections may be taken to these terms, as they do not by any means answer their intended end. If an insulated metallic cylinder is placed in the vicinity of excited glass, it will become electrified; the one end containing vitreous, and the other resinous, electricity, so that both kinds have thus been produced from the glass alone. Excited wax gives the same result, only that the end nearest the wax is resinous, whilst that presented to the glass is vitreous; thus it is impossible to produce the one without the other.

Franklin's hypothesis is to the effect, that there is only one kind of electricity. When glass is excited by means of woollen cloth, the glass receives from the cloth a quantity of the electric fluid in addition to its own natural supply, so that the woollen surface is rendered minus the quantity given out to the glass. In the Franklinean language, the glass is positively electrical, meaning that it is absolutely or certainly electrified, while the opposite term, negative, implies a contrary state. In accordance with these terms, excited glass is highly electrical, but excited cloth or wax is utterly destitute of electricity. Electricians have also objected to this theory, on the ground "that it involves an assumption at variance with the laws of gravitation, namely, that of matter being repulsive to itself."

In September, 1847, the author published a theory considerably different from Du Fay's or Franklin's. The chief features of this theory may be stated as follows:—When a ray of light is transmitted through a prism, it is separated into different colours, and these colours possess different energies, producing various effects, calorific, luminous, and chemical, pervading the entire range of the spectrum, and shifting from one colour to another, according to the nature of the substance upon which their functions are operating. Arguing upon this hypothesis, it is presumed that electricity, like light, in passing from an electric conductor, is resolved into different energies, possessing distinct appearances and effects. When a pointed wire is presented to an electrified surface, if the luminous appearance is that of a star, it may be considered that the electricity contained on that surface is positive, while the brush of light will show that it is negative. It is therefore presumed that, instead of the terms positive and negative, or vitreous and resinous, the different luminosities would be better calculated for affording distinguishing marks. In following out this idea, the author has been induced to substitute the word *étoile* (a star) for positive, and *pinceau* (a pencil) for negative. It has been already observed that in no case can we produce one energy without at the same time calling forth the other, and that both energies are equal in glass and wax, only that excited glass has the property of communicating first its étoile energy to other bodies, whilst wax gives out its pinceau first. This difference possibly depends greatly upon the form of the molecules of which they are composed, as their relative density, hardness, or softness, may affect their capacity for giving out or retaining their energies. When a jar is insulated, it cannot be charged with electricity; in this respect the fluid probably resembles material substances, for two bodies cannot occupy the same space at the same time, consequently when a jar is charged with active electricity, the latent or natural electricity of the jar passes to the earth, in order to give place for the accumulation of the former. In this state of matters the inside of the jar will be occupied by étoile energy, and the outside by pinceau; when a communication is made between the outer and inner coatings of the jar, the energies combine, and in passing through the air, which is a dialectric, light and sound are produced. The terms étoile and pinceau are equally applicable to voltaic electricity, for a Leyden jar may be charged from either of the wires of a voltaic battery with the same effect as from an ordinary frictional machine.

The simple experiment of the decomposition of water affords a good example of the effects of voltaic electricity. It is by this process that the power of batteries is measured. For this purpose a voltameter is

employed. This is a glass tube, hermetically sealed at one end and open at the other. Through the sealed end a platinum wire is passed, terminating in a small platinum plate. The tube is filled with a diluted solution of sulphuric acid; and another plate of platinum attached to a wire being introduced into the bottom of the tube, the two wires are connected with the battery, so as to bring the tube into the circuit, when the water is quickly resolved into its elementary constituents, oxygen gas being developed at the étoile electrode, and hydrogen at the pinceau electrode; the quantity of gas evolved in a given time affords an index of the power of the battery. When a solution of iodide of potassium and starch is made to form part of the electric circuit, the iodide of potassium is decomposed, and the iodine combines with the starch, forming the iodide of starch, which is of a fine blue colour. If a solution of sulphate of soda, coloured blue by an infusion of red cabbage, is put into two glasses connected by asbestos or wet cotton, on placing the étoile-electrode in one glass and the pineeau in the other, the blue liquid in the former glass will quickly become red, whilst that in the latter will change to green. The influence of the voltaic current resolves the sulphate of soda into sulphuric acid and soda, the acid appearing at the étoile, and the soda at the pincean, according to their electric relations. This holds good with every neutral salt, the acid always appearing at the étoile and the base at the pinceau; when the current is reversed by changing the wires, the red liquid will become green, and the green red; and, if the experiment is continued long enough, the acid and alkali will traverse the conducting asbestos in opposite directions, the liquids settling at their respective electrodes, one glass being found to contain an acid, the other an alkaline solution.

This curious experiment may be carried into effect in another way, by three watch-glasses connected together by shreds of wet asbestos; the glass next the pincean side of the battery is to be filled with a solution of sulphate of soda, the one on the étoile side with an infusion of cabbage, and the centre one with aqueous ammonia. If the apparatus is examined shortly after the action of the battery, a portion of the sulphuric acid of the salt will be found to have passed from the pinceau to the étoile glass, and, of course, must have traversed the ammoniacal liquor in the centre glass, without combining with it, as would have been the case if there was no electrical action upon it. From this circumstance Davy infers that in substances under the power of electricity, the usual chemical influence of combination is suspended.

Grotthuss and Faraday deny the existence of the transfer action of the ions, and affirm that the electric action is not exerted on any one portion or single molecule of the decomposing substance, but that rows of atoms lying between the electrodes, are all acted upon in the same degree. This is a vital point of disagreement, which we cannot here further discuss.

When solutions of metallic salts, as nitrate of silver, acetate of lead, or chloride of tin, are subjected to the action of electricity, decomposition ensues, ending in beautiful metallic precipitations. As an instrument for the detection of arsenical poisons, electricity possesses many advantages. The suspected liquid is put in a test glass, and a platinum electrode is attached to the pinceau end of the battery, and a copper one to the contrary extremity. When the two are placed in the liquid, if arsenic is present, a silvery deposit will take place upon the copper electrode. Intense electricity has also been employed to form crystals from water holding mineral substances, such as quartz or carbonate of lime, in solution. With a battery of 100 five-inch plates, Mr. Crosse succeeded in forming crystals of carbonate of lime, chalcedony, quartz, arragonite, carbonate of copper, phosphate of copper, and carbonate of lead, many of which were quite regular and transparent.

In 1840, the author discovered a method of testing metals and minerals by means of voltaic electricity; and a paper, descriptive of the process, was read before the Royal Scottish Society of Arts in 1843. The pincean electrode of a voltaic trough in action is connected with a piece of platinum foil, or a smooth block of lead. A slip of writing-paper, wet in a solution of ferro-cyanate of potassium, is placed on the platinum foil or leaden block, and upon this paper the metals to be tested, as, for example, iron, bismuth, copper, platinum, or palladium, are placed at a short distance from each other. If the metals are now touched with the étoile electrode, they will each give out distinct marks of colour to the paper. Iron gives a bright blue; bismuth, yellow; copper, brown; platinum, green; and palladium, light yellow. If the supporting paper is wet in a solution of hydro-sulphurate of ammonia, iron, lead, cobalt, nickel, silver, and mercury, give a black stain; bismuth, tin, copper, and platinum, dark brown; antimony, orange-red; chromium, green; cadmium and arsenic, yellow. The voltaic influence causes a precipitation of the combinations of the metals and their reagents upon the paper ground, thus indicating the nature of each metal by the colour it gives out.

In late years, our information on the subject of the intimate connection of electricity, magnetism, heat, and light, has been immensely extended, and the train of discovery now before us offers to lead to great results. To Professor Oersted belongs the credit of the discovery of the deflection of the magnetic needle when brought near a conducting medium; as also that of the magnetic condition of the needle when surrounded by a helix of copper wire, through which an electric current is passed. The production of the electric spark from artificial magnets, by Mr. Forbes, gave a fresh impulse to electrical improvement. By means of bent bar magnets and coils of insulated copper wire, the ignition of platinum is now easily accomplished, as well as the magnetising of iron bars, and the decomposition of water. In the latter operation, a cubic inch of mixed gases may be obtained from water in one minute and a half. The spark produced, when seen through a micrometer eye-piece, presents the appearance of a brilliant star, coloured with prismatic rays, a sufficient proof of the identity of electricity and magnetism. The intimate relation between electricity and caloric was discovered by M. Seebeck in 1821, and the result of this gentleman's inquiries has added another term to electrical nomenclature, namely, thermo-electricity. He found that by disturbing the equilibrium of metallic bodies, electric currents were excited. If a cylinder of bismuth is placed on a stand with copper wires twisted round the ends of it, the other ends of the wires being attached to a coil surrounding a magnetic needle, on heating one end of the cylinder with a spirit lamp, the needle will be deflected from its normal position. If the contrary extremity of the cylinder is heated, deflection will take place in an opposite direction; in both cases, the heated end of the cylinder is the étoile, and the other the pinceau. Thermo-electric batteries have been constructed, which decompose water, exhibit sparks, and give out powerful shocks.

Some philosophers suppose that earthquakes owe their origin to galvanic effects, produced by extensive chemical action; but the author is inclined to think that thermal powers, rather than chemical, are at work in connection with them. In a stratum of primitive rock, interspersed with metallic ores, extending for some miles, when the temperature is elevated or depressed by atmospheric changes, a quantity of electricity will be excited sufficient to cause an earthquake. In this country, earthquakes are most frequent at the beginning and end of winter, when sudden changes of temperature occur, and this fact may be said to strengthen the thermo-electric theory.

One of the most brilliant discoveries of this or any other age, is that by Dr. Faraday of the connection between electricity and light. By passing an electric current round a ray of polarised light in a plane perpendicular to the ray, he showed that the ray revolved on its axis. Light, like electricity, tends to reduce compound substances into simpler forms; and we have abundant means of proof of the essential changes which both organic and inorganic matter undergoes when exposed to the rays of light. The photogenic pursuits of Sir J. Herschel, Mr. R. Hunt, and others, bear very pointedly on this subject. Sir J. Herschel has observed that the transparent fluid obtained by neutralising the chloride of platinum with lime water is precipitated when exposed to the rays of light, although in the dark it undergoes no change for a great length of time. A converse result has been obtained by Mr. Hunt, who obligingly forwarded a sketch and description of his apparatus to the author of this paper. The arrangement consists of a test glass, and a small glass tube closed at one end by a piece of bladder. A solution of nitrate of silver is put into the test glass, and a solution of iodide of potassium into the tube, which is then placed in the solution of nitrate of silver, a communication being made between the two solutions by a platinum wire. When the apparatus is placed in the dark, precipitation ensues, but immediately stops when exposed to the light. Every new discovery appears to encourage the opinion of the identity of electricity, magnetism, light, and heat; and it may be that ere long we shall be able to chronicle the practical application of facts the importance of which is incalculable.

SERIES OF EXPERIMENTS RELATIVE TO THE FAN BLAST.

By W. Buckle, Esq., Soho Works, Birmingham.

[The paper, of which we here present a condensed report, forms a sequel to the one given at page 38 of our Number for May. It embodies the final results of the author's well-directed experiments, and leaves little to be desired in the way of practical information on the important subject investigated. On referring to the former paper, it will be found that the main investigation rested upon a theoretical question—whether the tips of the blades should partake of the same velocity as a body falling freely from a certain height, such height being governed by the density of air required. A comprehensive table of experiments given in the communication before us, confirms the previous conclusions on this head.—Ed. P. M. J.]

The fan employed was the same as the one detailed in the former experiments, the inlet openings being varied in diameter by adjustable rings of wood, the vane surface being modified accordingly. With an inlet 30 inches diameter, and vanes 8 inches long, width, as before, $10\frac{3}{4}$ inches, and same number of revolutions, the density of the air was equal to 6 ounces, the amount of power absorbed being 11·02 horses.

Inlet, $24\frac{3}{4}$ inches diameter; length of vane, 11 inches: width, $10\frac{3}{4}$ inches: 1,000 revolutions—gave a density of 5·8 ounces,—the power required being 6·1 horses.

Inlet, $20\frac{3}{8}$ inches; length of vane, $13\frac{3}{8}$ inches; width, $10\frac{3}{4}$ inches; 1081·6 revolutions—gave a density of 7·7 ounces, with 8·4 horse-power.

Inlet, 15 inches; outlet 4 inches deep, and 7 inches wide; length of vane, 16 inches; width, 6 inches; 786 revolutions—gave a density of 4 ounces, with 2·9 horse-power. The same, with the outlet contracted to 4 inches deep, with 885 revolutions, gave a density of 4 ounces, but required 8·25 horse-power. The table is drawn up with reference to several speeds of the fan, and the author's deductions are as follows:—

With a vane 14 inches long, the tips of which revolve at the rate of 236·8 feet per second, air is condensed to 9·4 ounces per square inch above the pressure of the atmosphere, with a power of 9·6 horses; but a vane 8 inches long, the diameter at the tips being the same, and having, therefore, the same velocity, condenses air to 6 ounces per square inch only, and takes 12 horse-power.

Thus, the density of the latter is little better than $\frac{6}{9}$ of the former, while the power absorbed is nearly 1·25 to 1. Although the velocity of the tips of the vanes is the same in each case, the velocities of the heels of the respective blades are very different; for, whilst the tips of the blades in each case move at the rate of 236·8 feet per second, the heels of the 14 inch blades move at the rate of 90·8 feet per second; and the heels of the 8 inch move at the rate of 151·75 feet per second; or, the velocity of the heel of the 14 inch moves in the ratio of 1 to 1·67, compared with the heel of the 8 inch blade. The longer blade approaching nearer the centre, strikes the air with less velocity, and allows it to enter on the blade with greater freedom, and with considerable less force than the shorter one. The inference is, that the short blade must take more power at the same time that it accumulates a less quantity of air.

These experiments lead me to conclude, that the length of the vane demands as great a consideration as the proper diameter of the inlet opening. If there were no other object in view, it would be useless to make the vanes of the fan of a greater width than the inlet opening can freely supply.* On the proportion of the length and width of the vane, and the diameter of the inlet opening, rest the three most important points, viz., *quantity*, and *density* of air, and expenditure of *power*.

In the 14 inch blade, the tip has a velocity 2·6 times greater than the heel; or, by the laws of centrifugal force, the air will have a density 2·6 times greater at the tip of the blade than that at the heel. The air cannot enter on the heel with a density higher than that of the atmosphere, but in its passage along the vanes, it becomes compressed in proportion to its centrifugal force. The greater the length of vane, the greater will be the difference of the centrifugal force between the heel and the tip of the blade; consequently, the greater the density of the air.

Reasoning, then, from these experiments, I recommend, for easy reference, the following proportions for the construction of the fan:—

Let the width of the vanes be one-fourth of the diameter.

Let the diameter of the inlet openings in the sides of the fan chest be one-half the diameter of the fan.

And, let the length of the vanes be one-fourth of the diameter of the fan.

In adopting this mode of construction, the area of the inlet openings in the sides of the fan chest will be the same as the circumference of the heel of the blade, multiplied by its width; or the same area as the space described by the heel of the blade.

The following table gives the sizes of fans varying from 3 to 6 feet diameter:—

TABLE OF BEST PROPORTIONS OF FANS.

Diameter of Fan.	Width of Vane.	Length of Vane.	Diameter of inlet opening.
ft. in.	ft. in.	ft. in.	ft. in.
3 0	0 9	0 9	1 6
3 6	0 $10\frac{1}{2}$	0 $10\frac{1}{2}$	1 9
4 0	1 0	1 0	2 0
4 6	1 $1\frac{1}{2}$	1 $1\frac{1}{2}$	2 3
5 0	1 3	1 3	2 6
6 0	1 6	1 6	3 0

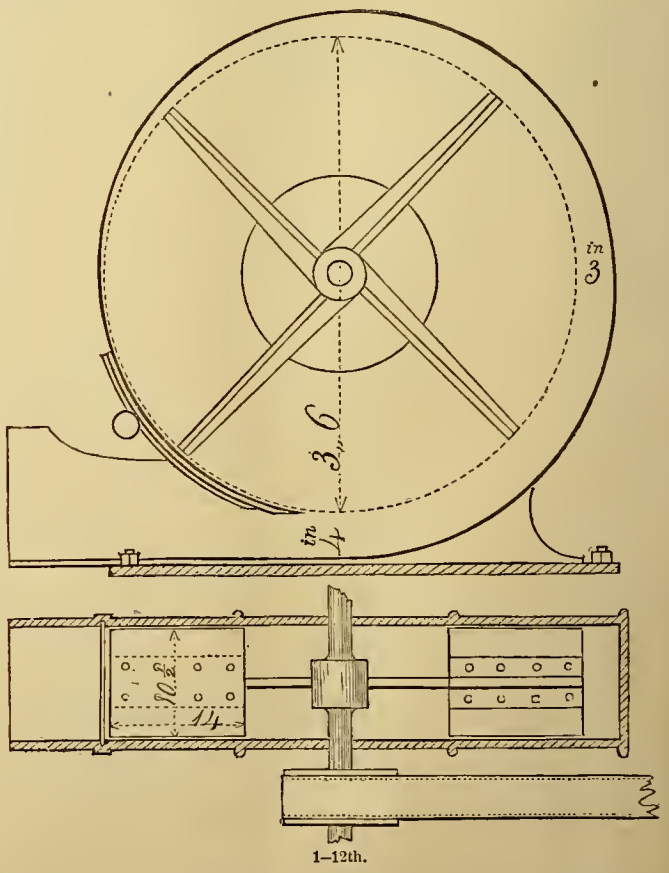
I recommend the proportions in the above table for densities ranging from 3 to 6 ounces per square inch, and for higher densities, viz. from 6 to 9, or more ounces, the sizes given in the following table.

Diameter of Fan.	Width of Vane.	Length of Vane.	Diameter of inlet opening.
ft. in.	ft. in.	ft. in.	ft. in.
3 0	0 7	1 0	1 0
3 6	0 $8\frac{1}{2}$	1 $1\frac{1}{2}$	1 3
4 0	0 $9\frac{1}{2}$	1 $3\frac{1}{2}$	1 6
4 6	0 $10\frac{1}{2}$	1 $4\frac{1}{2}$	1 9
5 0	1 0	1 6	2 0
6 0	1 2	1 10	2 4

The dimensions of the above tables are not laid down as prescribed limits, but as approximations obtained from the best results in practice.

In some cases, two fans fixed on one spindle would be found preferable to one wide one, as, by such an arrangement, twice the area of inlet opening is obtained, compared with a single wide fan; and they may be so constructed, where occasionally only half the quantity of air is required, that one of them may be disengaged by a clutch, and thus a saving of power effected. In a single fan of great width, the inlet opening must either be made too small in proportion to the width of the vane, or if it is made large enough for the width of the vane, the length of the vane becomes so short as to be quite incapable of producing air of the required density.

It has been stated that the air from the fan chest is impelled by the vanes along the transit pipe, to the blast chest, &c.; I beg attention to the results of an experiment very recently made by me, with reference to the admission of air into the transit pipe, and which, I think, may lead to an important improvement in the fan. The experiment alluded to, was made to enable me to ascertain the result of varying the area of admission to the transit pipe, in proportion to the quantity of blast required for use; and I effected this by adapting a segmental slide to the circular chest of the fan, as shown in the accompanying section, by means of which I vary the width of the opening into the transit pipe from 12 to 4 inches.



1–12th.

The object of this arrangement is to diminish the transit pipe opening at pleasure, in proportion to the quantity of air required, and thereby to

* The proportion a suction pipe bears to a pump, is an analogous case; for, if we drive the bucket at a greater velocity than the suction pipe will supply it with water, the consequence will be, that we shall not lift so much water, at the same time that we absorb more power.

lessen the power necessary to work the fan. The inlet opening to the transit pipe having been contracted from 12 inches to 4 inches deep, so that the tip of the vane and the bottom of the outlet opening were nearly in a direct horizontal line, nearly the same quantity of air was impelled, as with the original opening; the noise produced by the fan had, however, nearly ceased. It therefore appears, that the less this opening is made—provided we produce sufficient blast—the less noise will proceed from the fan; and by making the top of this opening level with the tips of the vane, the column of air has little or no reaction on the vanes.

With respect to the degree of eccentricity which the fan should have with reference to the fan chest, $\frac{1}{10}$ of the diameter of the fan has been found in practice to answer well; that is, the space between the fan and the chest should increase, from $\frac{3}{8}$ of an inch at the top of the inlet to the transit pipe, to $\frac{1}{10}$ of the diameter of the fan at the bottom of a line perpendicular with the centre. The tunnel, or main pipe, from the fan chest may for short distances, varying from 50 to 100 feet in length, be made not less than $1\frac{1}{4}$ times the area of the transit pipe in the fan chest; and in distances varying from 100 to 200 feet in length, $1\frac{1}{2}$ times the area of the transit pipe. The length of a tunnel may be continued to 300 or more feet, provided it be made of sufficient dimensions to allow the air to pass freely along it. The experiments accompanying this paper were made with a tunnel 18 inches diameter and 160 feet in length, and no difference could be detected in the density of the air, when the guage was applied at any part of the tunnel.

Having investigated the leading characteristics of the fan, it may not be ont of place to give a few hints respecting its mechanical construction.

First.—It is one of the greatest essentials, that all parts maintain a just and proper balance.

Second.—That the arms of the fan be as light as is consistent with safety: round arms are decidedly objectionable; I have known instances when their centrifugal force has torn them from the centre boss. I prefer the rectangular arm, abont the proportion of $2\frac{1}{4}$ times the width, for the depth at the centre, with sufficient taper towards the tips.

Third.—The bearings and journals of the fan spindle should be made of a length not less than four times the diameter of the necks of the spindle.

Finally.—The driving pulleys should be made as large as circumstances will admit of, so that the strap may have sufficient surface to prevent slipping.

The fan from which my experiments were collected was made with these proportions. It has been at work nine years without any perceptible wear.

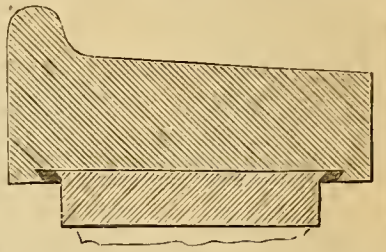
The application of the fan has hitherto been chiefly applied to smithies and foundries; and in bnt few instances has it been applied to the smelting of iron ore. I am aware that differences of opinion exist as to the applicability of the fan to that purpose. The principal reason urged against it, being the limited density to which the blast can therehy be compressed, compared with the blast supplied hy the cylinder. It remains however to be proved, whether such high densities are absolutely necessary for the smelting of iron ore; whether we may not produce as good iron by a diffused soft hlast, as by a strong and generally applied concentrated hlast. I hope it will not be thought presumptuous on my part, in thns donbting long-established practices. The old maxim of "there's no way like the old way," is not always based on unerring principles.

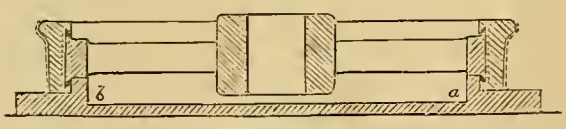
As I bave before stated, the density of blast afforded hy the fan is limited to the force arising from the centrifugal motion of the air in passing along the vanes of the fan, the quantity not exceeding what is due to its velocity and magnitude. But may not this density he increased by using a succession of fans, so constructed and arranged, that the air may be passed snccessively tbrongh each, the air from the first fan being made to enter the second, the air from the second to cnter the third, and the hlast finally emitted of adequate density?

I cannot here enter into a further investigation of this important subject; neither are the limits and character of this paper suited to the minntiæ connected with the principles and practice of a smelting furnace; but I hope that the observations which I have made, and the principles I have endeavonred to cnunciate, will be the means of instituting further inquiry; and, as the expense of constructing a fan can be no barrier, I trust that a fair trial will bc made, where convenience is suited to its application for smelting pnrposes.

EVANS'S IMPROVEMENTS IN FITTING ON RAILWAY WHEEL TYRES.

Mr. Edward Evans, of the Haigh Fonndry Co. near Wigan, has lately introduced an ingenions system of attaching tyres to railway wheels. By this plan, no screws or rivets are required; the attachments being entirely effected hy means of a fusible metal joint. The annexed wood-cut is a section through a tyre and inner wheel rim or spokes, thus fitted. A dovetailed groove is formed along the inner surface of the tyre, and a dovetailed projection upon the spokes. When an inner rim is employed, the patentee forms such ring of iron, rolled on one side, with a dovetailed projection, so that this iron, when beat into a circle, will have on its exterior portion a continuous dovetail projection, which may he fitted into the tyre or hoop, the spokes heing attached to such inner ring and the nave, according to any of the usual well-known methods. Or the inner ring may he formed of segments by bending iron, with a dovetail projection as described, into segments which are to be brought into close contact at their sides and fastened together, and into the nave by any of the usual methods. These segmeuts will present an inner ring or periphery, having a number of dovetail projections on its outer surface. The dovetail groove iu the tyre is made wider at its narrowest part than the dovetail projection of the spokes or inner rim is at its widest part, so that the latter will easily enter into the former when the tyre is shrunk on. The dovetail projection will not fill the groove, but will leave a space which is to be filled up, as will be afterwards described and explained. The groove in the tyre and the dovetail projections to be introduced into it, and the relative dimensions and sizes of the several parts, must be adjusted to each other according to the purposes for which the wheel is required, so that the part which forms the side of the groove, or the inner surface of the tyre or hoop of the wheel, may pass over the ends of the spokes, or the outside of the inner ring or periphery, when the tyre is heated to be shrunk ou, and that the bottom of the groove may come into close contact with the ends of the spokes, or the outer surface ring or periphery of the wheel, when the tyre is contracted by cooling, or shrunk on, as is well understood in the manufacture of wheels. Our second illustration is a section of a wheel and tyre, and the plate on which they are both laid in a horizontal position, for the purpose of the tyre





being shrunk on; the dotted lines in the section of the tyre will show its position when hot, and the full lines the position when it is cold. The plate on which they are laid may either have a rih cast on it, as at *a b*, or it may be a plain plate, and small packings may be used instead of the rib; but the wheel, when fixed on the plate, must be raised either by the rib or the packing pieces, so that the groove in the tyre, when put round the wheel, will be level with the rim of the wheel, and in such position that the one will easily enter the other, as the tyre becomes contracted by cooling. When the wheel has heen fixed on the plate, and the hoop or tyre heated in a furnace, as is commonly practised in hooping wheels, the tyre will have become expanded, and will pass over the wheel so as to encircle it. Now it will be evident, that as the groove is rather wider at its narrowest part than the projecting dovetail is at its widest part, and the tyre has contracted so as to bring the one within the other, there will he a space left on the sides, that is, hetween the sides of the groove and the sides of the projection, and the dovetails would in that state form no joint or security for holding the one to the other. In order to make tbis a perfect joint, the spaces on the sides are filled with melted metal or other hard substance, as zinc, as being the hardest aud cheapest of the easily melted metals. There would be a difficulty in getting the tyre off the wheel for any purpose of repairs, if the metal were not of a kind to be easily melted. If it is thought desirahle, the wheel may be shifted as tbe tyre gradually cools, so as to bring one side of the dovetail projection in contact with the side of the groove, and thus leave only one side to be filled. The dark parts in both views represent the metal which has been run in, and thus made to form the joint, so as to prevent the tyre separating from the wheel. The rim of the wheel may be made of iron, rolled or forged into the required shape, or it may he turned to the proper shape in a lathe, and the dovetail groove in the tyre may be formed in a lathe, or it may be formed in the manner following: The tyre har, which is intended to form the hoop of the wheel, must first he rolled into tho shape as shown in the section, by suitable grooves made in the rolls; it is

then passed through a groove in the rolls, of the ordinary shape for making tyre bars, and the angular projections will be deflected towards each other, and will thus make the groove in the tyre sufficiently dovetailed, for the purpose of holding the tyre and the wheel together.

These angular projections may also be depressed and thrown inwards by hammering while the bar is hot, and without going through the last groove in the roll.

This method of attaching tyres appears to offer many advantages over those at present in use; it is simple, and, if the zinc holds, we should say, most effective.

ROBERTSON'S WHEEL TYRE BENDING MACHINE.

Illustrated by Plate 5.

This is a simple and effective machine, intended for bending the tyres of railway wheels, as an improvement upon the usual unmechanical system of hand-bending. It was designed about two years ago by Mr. P. Robertson, the superintendent of locomotives of the Glasgow and Ayr Railway, in whose workshops it was proposed to be erected; but, owing to want of room, this has not yet taken place. Our plate represents a vertical section of the machine, showing its position in the masonry, and a plan of the whole in working order.

A circular cast-iron frame, A, is fitted down on the top of the masonry over the pit which receives the main shaft and gearing. In the interior of this circular frame is cast a triangular bracket, represented in dotted lines in the ground plan; the centre of this bracket forms an eye for the reception of the brasses for the upper bearing of the main shaft, B, the foot-step of which is formed in a plate resting on the masonry at the bottom of the pit. The upper extremity of the main shaft is formed with a deep shoulder, upon the end of which a revolving plate, E, 6 feet 6 inches diameter, is bolted, being fitted on by a central eye or boss, which embraces the shoulder. An ordinary blocking plate, D, is bolted down upon the surface of the plate, C, so as to be removable at pleasure to suit different sizes of tyres. The bending roller, E, which is turned on its periphery to fit the exterior surface of the tyre, is carried by a short vertical shaft revolving in bearings fitted into grooves in the two projections of the fixed frame, A. These bearings are attached to the ends of two horizontal screw shafts, F, which work in the screwed bushes of two worm wheels, G, supported in bearings on the extremity of the projections of the frame, A. The two worm wheels are geared with a vertical worm shaft, supported in a foot-step on a bracket of the bottom projection, which shaft passes upwards through the centre of a column, H, bolted to the top of the frame. The top of this column is surmounted by a winch-handle fast on the end of the worm shaft, by which motion may be given through the worm wheels and screw shafts, to the bearings of the shaft of the bending roller, E, so as to set the latter at any required distance from the blocking plate, D.

The main shaft carrying the blocking plate is driven by the horizontal shaft, I, carrying a bevel pinion gearing with a bevel wheel on the vertical shaft, K, supported at its lower end in a foot-step on the bottom plate carrying the main shaft. This shaft, K, is carried at its upper end in a bearing of the triangular bracket of the main frame, and is fitted with a pinion gearing with an internal wheel, bolted by a flange to the lower surface of the revolving plate, C. A machine of the size here shown, is capable of bending tyres from five to six feet in diameter, but any size of tyre may be bent by changing the blocking plate, or altering the position of the bending roller. In working, one end of the tyre bar is first passed between the bending roller and the blocking plate in the usual manner, and the bending roller is then screwed hard up against it by the winch-handle. The revolving plate is then put in motion, until the two ends of the tyre meet, when the bending roller is screwed back, and the tyre lifted off the plate.

As at present performed, the result of a day's labour of ten men bending round a blocking plate by hand is only about twenty bent tyres; with this machine, the same number might be got through in half an hour. The Glasgow and Ayr Railway Company are contemplating the erection of very extensive workshops for locomotive building and repairs, and Mr. Robertson's machine will then be put in action on the large scale.

OSCILLATING MARINE ENGINES, WITH THE "LINK"—REVERSING AND EXPANSION MOTION.

Illustrated by Plate 6.

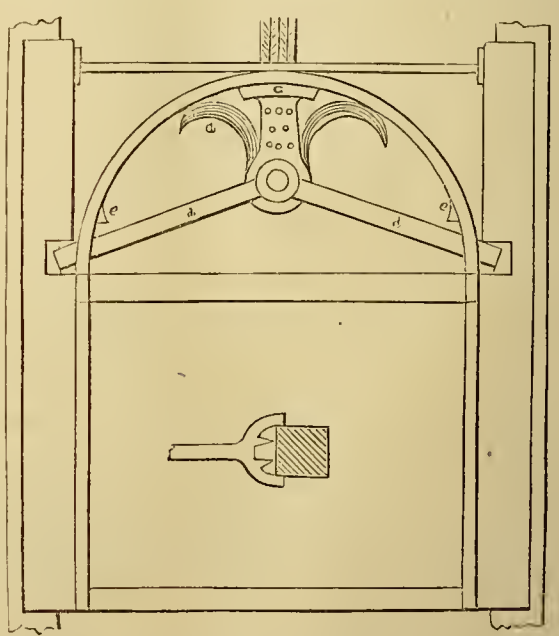
The pair of engines, of which we give a complete elevation in Plate 6, have been lately set to work in a steamer on the upper Danube. Although possessing many features of practical ingenuity in their minor details, their chief peculiarity consists in the application of the double eccentric "link," as fitted to modern locomotives. For the navigation of crowded rivers, where stoppages and backings are frequent, something more than the single loose eccentric and hand-gear is evidently required as a preventive of accidents by collision, and the link is decidedly the most advantageous apparatus for the purpose. The motion is given direct from the eccentrics, and in this point alone the system is very superior to the usual complication of crooked weigh-bars and levers. The reversing lever is fast on a transverse shaft running right across from one engine to the other, so that the engineman is thus enabled to start, stop, or reverse both engines with a single movement. A notched segment is fitted up in connection with the reversing lever, for the purpose of setting the links at any point upon the valve studs, so as to work expansively.

The whole arrangement of the engines and valve-gearing is by Mr. Joseph Hall, formerly of Newcastle, but now residing in Munich, who has favoured us with the original drawings, from which our engravings were made. In our July number, we shall give the remaining views, including a side elevation of the air pump and condenser, and ground plan of the whole. We shall defer further remarks until these drawings are laid before our readers.

SELF-ACTING SAFETY WINDING CATCH FOR MINE SHAFTS.

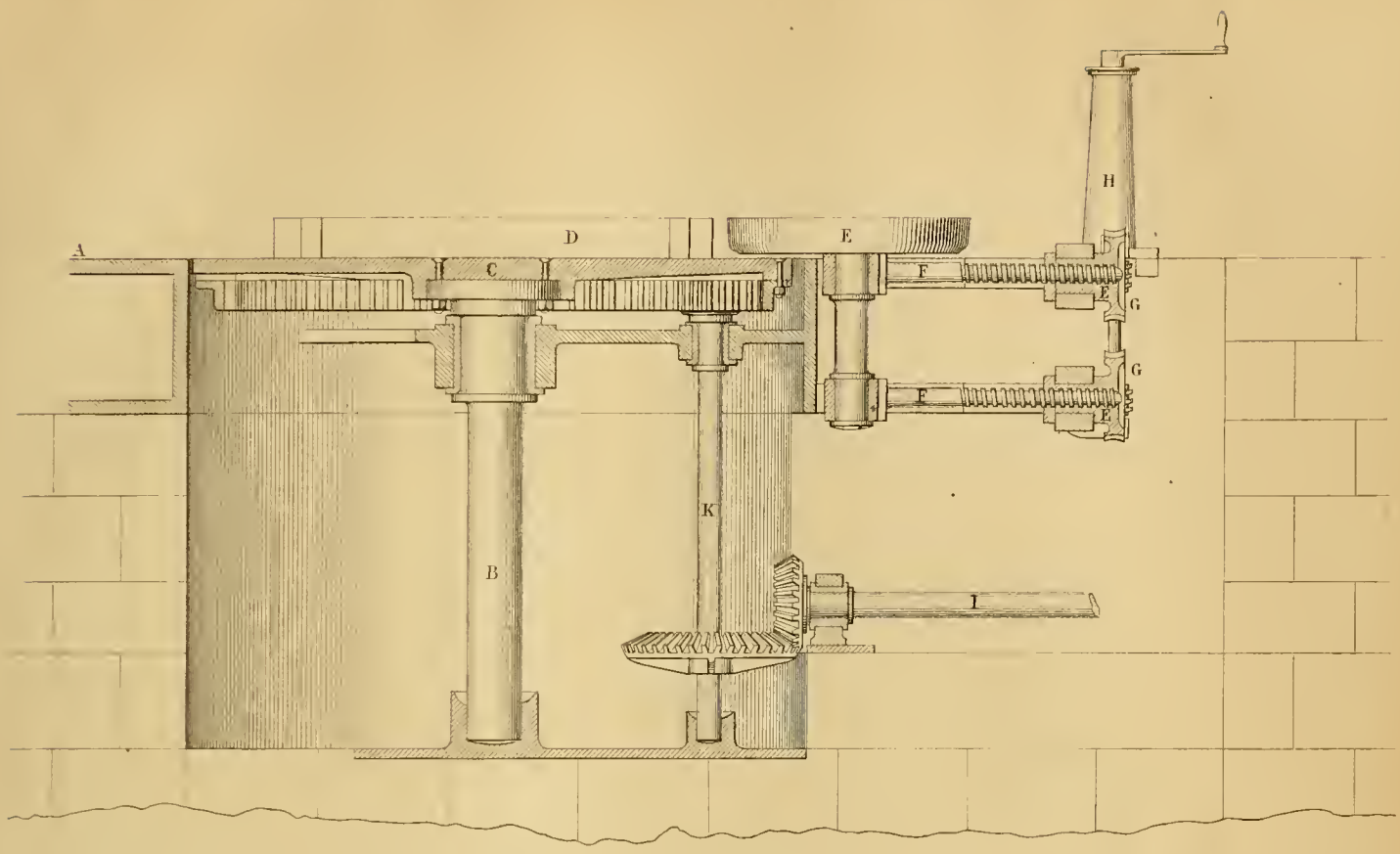
Next to bad ventilation, one of the worst dangers which the miner encounters in his dreary occupation, is that attending his ascent and descent through the mine shafts. In the early days of mining, the only mode of access to the underground works was by a basket or corve swung loosely by a rope, the adventurous miner guiding himself in his passage by a staff applied from time to time to the uneven sides of the shaft. Gradually the tide of improvement set in, and slides were introduced to guide the cage as on a vertical railway. Still, no provision was made for the prevention of accident from the breakage of the suspending ropes; and we well remember the thrill which passed through our frame on first descending a shaft, when we reflected upon the probable result of the failure of the rope, with some two hundred fathoms of clear space below us.

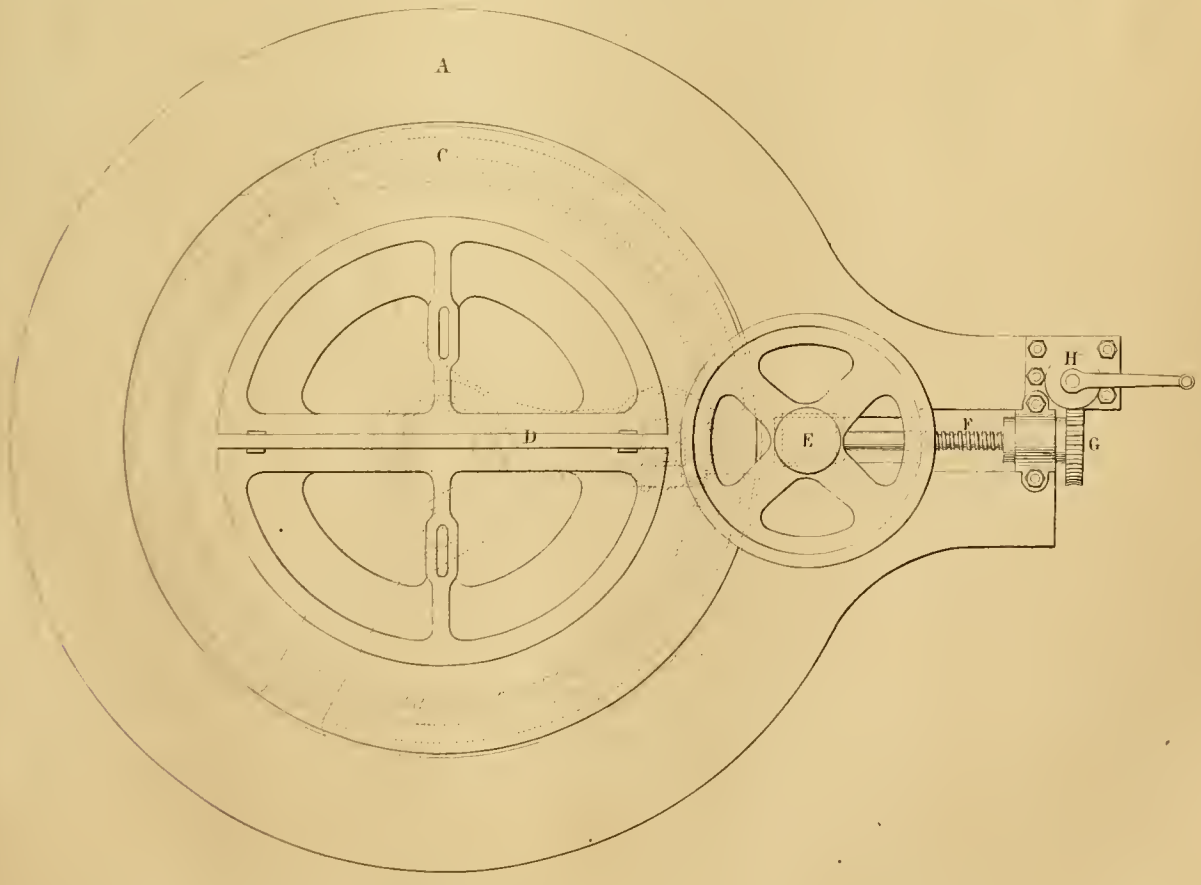
Amongst the many schemes latterly proposed for the better security of the miner, we have selected an arrangement, by Mr. George Simpson of this city, whose pit valve we published at page 13 of our April number. The accompanying wood-cut is a side elevation of a cage as fitted



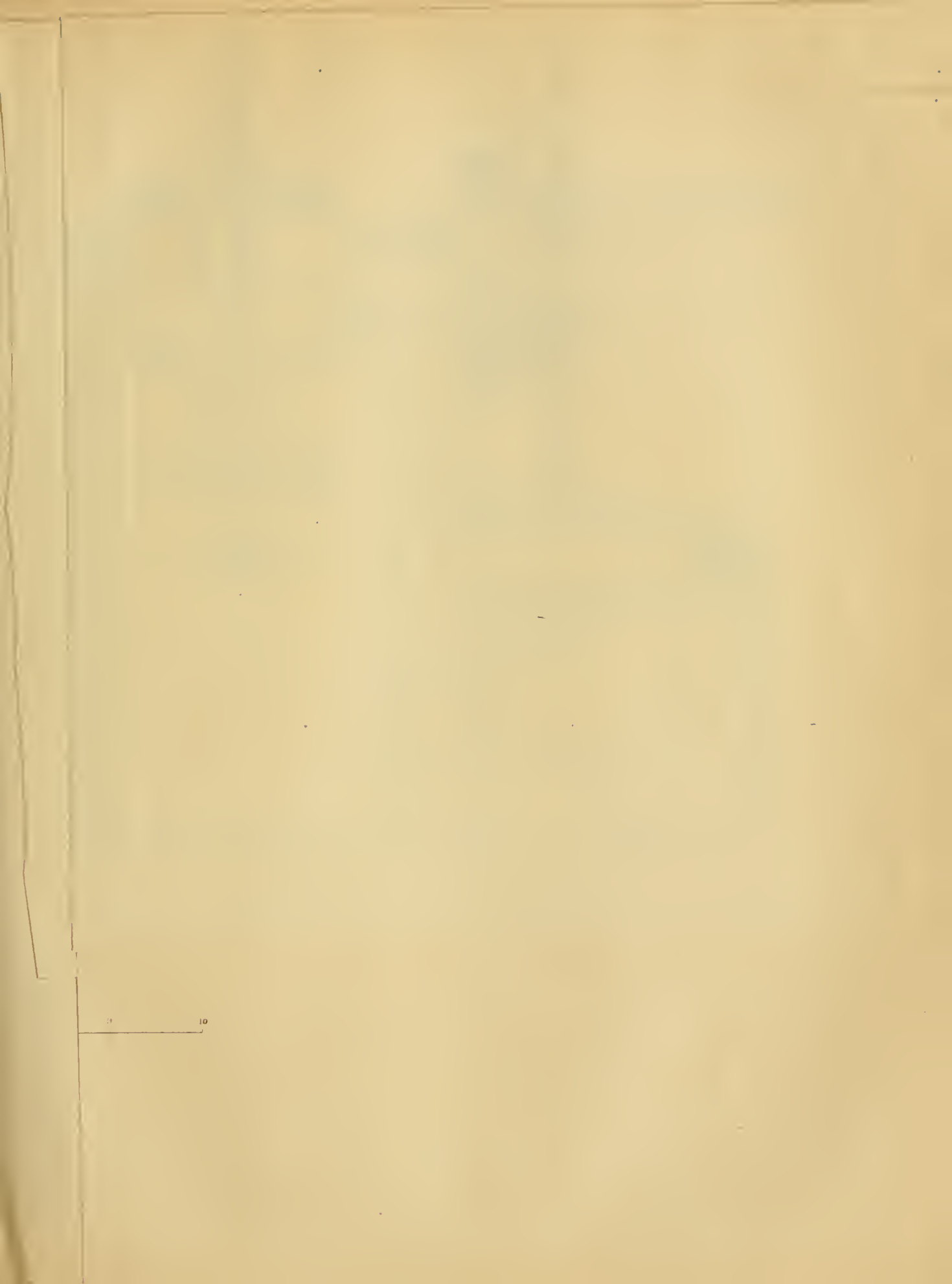
with Mr. Simpson's contrivance. The stud, or spindle, by which the suspending rope is attached to the cage, carries two strong springs, *a a*, the loose ends of which springs abut against the semicircular bar, *b*, at the top of the cage. As the cage ascends or descends, its whole weight comes upon the springs, until a guard, *c*, on the connecting link of the rope, comes against the lower surface of the semicircular bar, *b*. Two

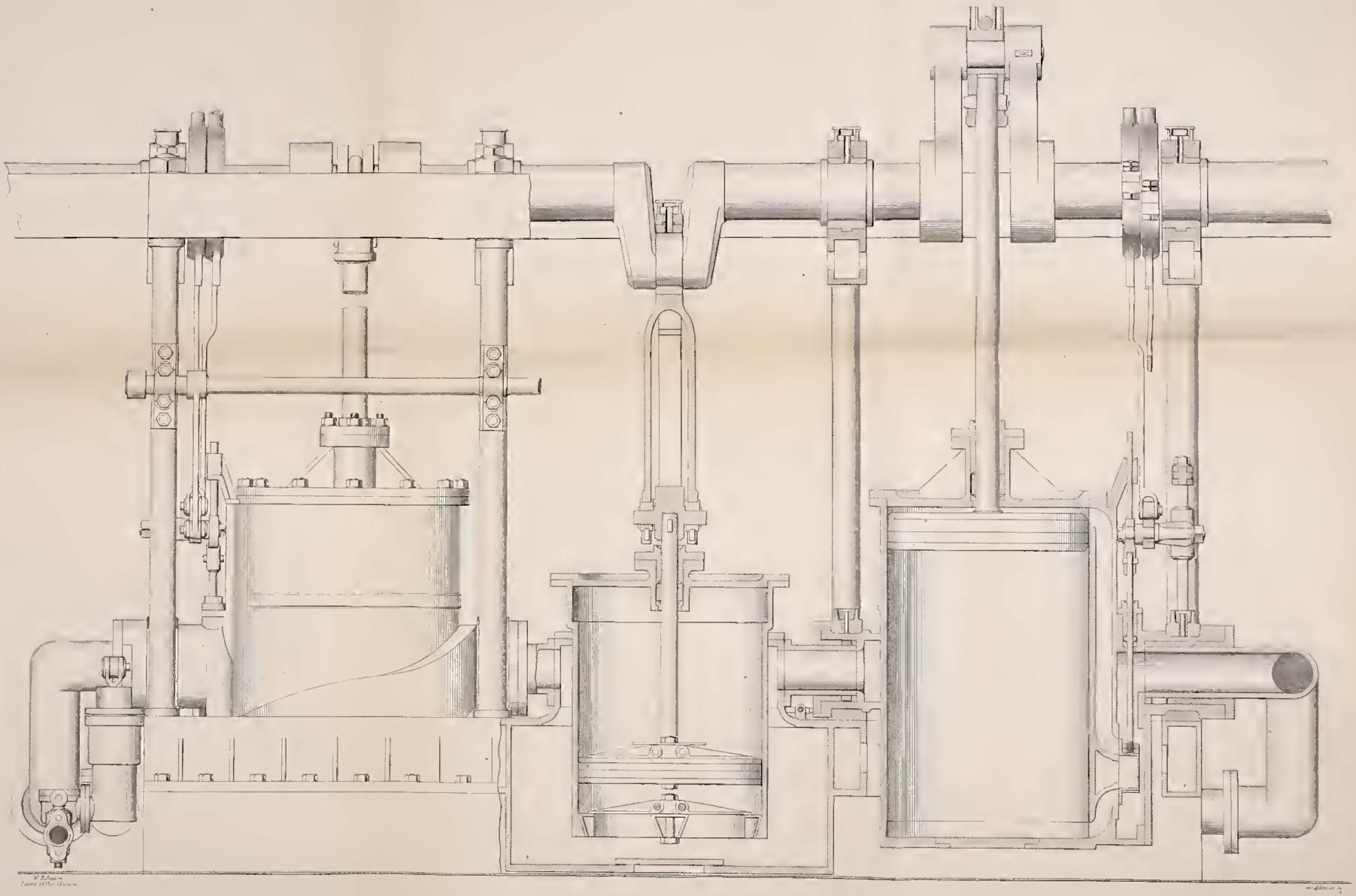
ROBERTSON'S WHEEL TYRE BENDING MACHINE.





12 6 0 1 2 3 4 5 10 Feet


0
10



Scale

links, *d d*, are hinged to the central spindle, so as to form a knee-joint their two ends projecting through slots in the sides of the cage. The detached figure in the open space within the cage, is a horizontal section of one of the cage guides, shewing the extremity of one of the links, *d*, embracing the guide. In ascending or descending, the weight of the cage and materials coming npon the two springs, *a a*, raises the central spindle, and causes the links, *d d*, to take up the position shown in our engraving; but should the rope give way, the abstraction of its tension from the springs will immediately permit of their reaction upon the central knee-joint, so as to bring the extremities of the links, *d*, hard np against the inner sides of the cage guides, openings being cut in the slides to permit of the ends of the links passing through. The whole weight of the cage then rests upon these links by the projections at *e e*, against which the links will be forced. In the plan of the ends of the links, as represented in the central detached figure, it will be observed that the interior of the fork embracing the cage guide is furnished with projecting points to catch firmly in the wood when the reaction of the springs brings down the central joint of the links.

The plan is exceedingly simple, the whole additional apparatus being the springs and the jointed links, no alteration being necessary in the guides or in the lining of the shaft. It has not yet been put in practical operation, but a large-sized model has been tested so far as to leave no doubt of the efficiency of the arrangement on a working scale.

EXPERIMENTS WITH NARROW GUAGE LOCOMOTIVES.

On the 4th, 5th, and 6th of May last, a series of well-conducted experiments were made on the Midland railway, with a view to the testing the capabilities for power and speed of two varieties of recently constructed narrow guage locomotives.

The locomotives with which the experiments were made, are new classes constructed by Messrs. Sharp Brothers and Co. of Manchester; and Messrs. Wilson and Co. of Leeds. Two of Sharp Brothers and Co.'s engines employed in the experiments, were Nos. 60 and 61. They are each of the following dimensions:—The number of tubes is 161, of two inches diameter outside, and 10 feet long. The heating surface 847 feet, and the fire-box 72 square feet. The cylinder is 16 inches, the stroke 20 inches, and the driving-wheel 5 feet 6 inches diameter. Two also of Messrs. Wilson and Co.'s engines, Nos. 26 and 27, were employed. They belong to what is called the "Jenny Lind" class. They have each 124 tubes of 2 inches diameter outside, and 11 feet long. The heating surface is 800 feet, and the fire-box has 87 square feet. The driving-wheel is 6 feet diameter, and the length of stroke 20 inches.

It was determined by Mr. Kirtley, the able locomotive superintendent of the Midland Company, under whose direction these experiments were made, for the purpose of determining the relative working value of the two classes of engines, that the first trip should be made with a train of about 64 tons, exclusive of engine and tender. Nine of the ordinary first and second class carriages, with a break van at either end of the train, were loaded with railway chairs, and these gave by the machine a weight of 64 tons.

Messrs. Sharp Brothers and Co.'s engine, No. 60, led in the experiments. The weight of the engine, in working order, was 21 tons 9 cwt., and the tender, with its water and coke, 12 tons 11 cwt., or together 34 tons. The gross load, therefore, was 100 tons. The trip was from the Derby station to Masboronghstation, about 40¼ miles. For the first 20 miles, the gradients average a rise of 1 in 330, and for the remaining 20 miles the gradients fall in the same proportion. The weather was very favonrable for the experiments, the rails dry, and scarcely a breath of air stirring. Among those who accompanied the experimental trips were Mr. Kirtley, Mr. Marlow (the assistant locomotive superintendent), Mr. Harland (the carriage inspector), Mr. Haywood (the locomotive foreman), Mr. Wilson (the maker of the engines Nos. 26 and 27), Mr. Fenton, and Mr. Crampton. The engine (driven by William Hodgkinson) left the Derby station at 3h. 39m. 45½s. and performed the trip in a little less than 49 minutes, or at the rate of about 49 miles per hour; the first 18 miles, np 1 in 330, were accomplished in 25 minutes 12½ seconds, or at an average speed of nearly 43 miles per hour. The steam of the engine was np two hours before starting, and the water in the tender was, at the time the train left Derby, nearly at boiling heat.

The amount of coke served ont to the engine, including that for getting up steam, was 23 cwt. The amount in the tender and fire-box, on her arrival at Masboronghstation, was 7 cwt., so that the total consumption was 16 cwt., or 44.8 lbs. per mile. The total quantity of water evaporated is stated to have been 10,290 lbs., or 257.2 lbs. per mile, showing therefore 5·7 lbs of water evaporated per lb. of coke. The engine came into the station without any water in her tender, which was full when she started from Derby.

The next trip was with "Jenny Lind," No 27; the weight of this engine, including water and coke, was 24 tons 1 cwt.; and her tender, with water, 15 tons 13 cwt., or together, 39 tons 14 cwt., giving a gross load of 103 tons 14 cwt. The engine (driven by William Carter) left the Derby station at 7h. 10m. 20s. and performed the journey in 46 minutes 22 seconds, at the rate of nearly 52 miles per hour, the first 18 miles up 1 in 330, having been gone over in 22 minutes 44¾ seconds, or at the average rate of nearly 47 miles per hour.

The total amount of coke consumed, including getting up steam, was 13 cwt., or 36.4 lbs. per mile. The quantity of water evaporated is not stated.

The following are the comparative workings of the two engines up the gradients to the 17th mile post:—

Mile-posts.	Sharp Brothers and Co.'s Engine. Miles per hour.	Wilson and Co.'s Engine. Miles per hour.
1	21.6	21.9
2	39.6	44.5
3	42.0	51.0
4	42.5	51.4
5	45.4	51.4
6	46.8	51.2
7	44.5	48.9
8	46.2	50.0
9	47.0	52.5
10	46.8	52.0
11	45.9	51.4
12	45.9	53.3
13	45.6	52.7
14	46.6	51.8
15	—	
16	48.0	51.4
17	47.8	51.8

The next trips were taken with 17 carriages weighted to 99 tons 16 cwt. About 20 persons went down in the carriages to witness the experiment, among whom was Capt. Symmons, the government railway inspector. The gross load of the train was about 101 tons. Sharp Brothers and Co.'s engine was with this trip driven by William Mould, one of the best drivers upon the Midland railway. The total consumption of coke was 16 cwt., or 44.8 lbs. per mile; and the water evaporated 10,840 lbs., or 27.1 lbs. per mile. The quantity of water evaporated per lb. of coke was 6 lbs.

The parallel trip with Messrs. Wilson and Co.'s engine No. 26, driven by William Barrow, shows a consumption of coke of 12 cwt., or 33.6 lbs. per mile, and the total water evaporated 10,116 lbs., or 252.9 lbs per mile. The water evaporated was 7.5 lbs. per lb. of coke. In this experiment the steam was got up six hours before starting, kept up for one hour, and then let down again till the fire was nearly out, under the impression that No. 27 engine would be again employed. About two hours before starting the steam was again got up. A loss of two cwt. of coke has been allowed for this.

It is seen by the above working that up to the 18th mile post (that is, on a rising gradient of 1 in 330) the 6 feet driving wheel engine of Messrs. Wilson and Co. had travelled at an average speed of rather more than 41 miles per hour, viz., in 26 minutes 19 seconds; while the 5 feet 6 inch driving wheel engine of Messrs. Sharp Brothers and Co. went over the same ground in 27 minutes 55 seconds, or at the rate of 39.3 miles per hour. The relative performances up to the 18th mile post stand thus:—

Mile-posts.	Sharp Brothers & Co.'s Engine. Miles per hour.	Wilson & Co.'s Engine. Miles per hour.
1	15·0	18·3
2	36·5	40·9
3	48·0	45·6
4	42·4	46·8
5	43·9	46·8
6	43·9	46·2
7	41·9	43·4
8	42·4	43.4
9	43·9	44·5
10	43·9	44·5
11	44·5	44·5
12	43·9	45·0
13	43·4	45.0
14	43·4	44·5
15	—	45·0
16	42·9	43·9
17	42·9	42·4
18	41·9	41·4

Sharp Brothers and Co.'s engine, with the 101 tons, went over the 3 miles from the 18th to the 21st mile-post in 3 minutes 47 seconds, or at 47·4 miles per hour, while Messrs. Wilson and Co.'s engine went over the same distance, with the same load, in 3 minutes 54 seconds, or about 46 miles per hour; but up to the 30th mile the relative performances had been as follows:—viz., Sharp Brothers and Co.'s engine 43·3 miles per hour, Messrs. Wilson and Co.'s engine 44·4 miles per hour. It will be seen that from this point the latter or larger driving wheel engine ran at less speed down the 1 in 330 than the smaller driving wheel engine, although it had gone up a similar gradient nearly two miles per hour faster. This difference is, perhaps, easily explained by the fact, that the driver allowed his fire to get so low that he was obliged to feed the engine within 4 or 5 miles of Masborough station, where he arrived with a black fire, and with scarcely sufficient steam to shunt the train. He had altogether miscalculated the condition of his fire, or had neglected to fire at the proper time. In fact, the trial was not considered to be a fair one, and Mr. Kirtley ordered a second trip to be made on the following day (Saturday). The trial was equally useless as a test of the capacity of the engine. When the engine had got about a mile out of Derby, a cover-joint of one of the cylinders worked loose, and a considerable amount of steam found its way out during the remaining 39 miles of the trip.

As regards speed and satisfactory working, we believe these are the best experiments on record, but we had expected to have found a lower rate of consumption of fuel. In the trials made some time back under the superintendence of the guage commissioners, with the "great A," outside-cylinder long-boiler engine of Stephenson, an average speed of 47 miles per hour only was obtained, with a load of 50 tons; with a load of 80 tons, 44 miles was the speed. We believe further trials are about to be instituted, of which we shall take due notice.

PROTECTION AGAINST FORGERY.

The facility with which ordinary bank notes, cheques, and signatures, may be imitated, has contributed largely to the extension of the crime of forgery, and the ingenuity of scientific men has long been called into action as a counteractive force for the protection of the public.

Some twenty years ago, a clever idea was proposed for this end, and, we believe, partially acted upon by a London firm. It consisted in "marbling" the note or cheque at the part where it was intended to be separated from its counter-check; it would thus be impossible to match the counter-check by any other note than the one actually cut from it.

Marbling will be familiar to the reader as a finish on the edges of the leaves of books, and as an ornamenting surface for book backs. It is thus performed:—A solution of mucilage of linseed is placed in a wide shallow vessel, and the required colours, ground in turpentine or ox-gall, are sprinkled on the surface of the liquid. Owing to the repellant properties of turpentine and ox-gall, the colours mixed with these vehicles, when sprinkled together, form a species of broken drops, somewhat like extended oil drops floating on water. The mixture and proportion of colours are varied by the workmen according to their own ideas of effect; and occasionally a kind of mechanical pattern is produced by passing a stick, or the teeth of a comb, through the surface of the liquid carrying the floating colours, thus producing a kaleidoscopic system of contortions in the drops of colour. The paper, or surface to be marbled, is then carefully laid on the liquid, from the surface of which it absorbs the different colours, in whatever position they may happen to be at the time of dipping. The paper, coloured in this fashion, is then hung up to dry, and is finished by burnishing. The resultant pattern is then the entire production of chance; for, as the colours are sprinkled on the water and mingled at random, the actual design can never be foreseen or imitated with exactitude, as, although two marbled patterns may resemble each other very closely, no two portions can ever be accurately joined without some discrepancies of colour and outline. It is to chance alone that we owe the safeguard against imitators, for no *systematically produced* difficulty—as, for example, the extraordinary miniature repetitions of Perkins & Bacon—can act as an efficient protector; such attempts simply increase the difficulty, but do not bar the execution of copies.

Although, as we have seen, this plan is well adapted for its object, as far as regards the particular cases of bankers and others who hold the counter-checks, it is yet no protection to the public, who do not possess this key to the documents they may hold. The slowness of the process of marbling offers another objection, and, owing to these drawbacks, the system has been abandoned as useless.

Perhaps the best mode now in operation is that adopted by the Board of Excise for their labels on paper and patent medicines. It is termed "compound plate printing," and consists in the printing of two colours at once. It is the invention of Mr. Charles Whiting, of Beaufort House, London, who has secured it by patent. A brass plate is pierced according to any desired pattern, and separate plugs of brass are fitted into the openings so made. When the holes are all filled in this manner, type metal is poured upon the back of the plate to unite the plugs, which are made to project some distance from the plate; the type metal and detached plugs thus forming a separate plate, the projections or plugs on which correspond exactly with the various insterstices of the pattern in the original plate. The two plates are then screwed together, and planed to a true surface, on which the design is engraved. When the plates are separated, the device is found to be partly on each plate, and the two are then inked with different colours, again screwed together, and printed from at a steam press. This system is now in actual practice in the Somersetshire Bank of Messrs. Stukey & Co.

An additional practical difficulty has been lately introduced, in the shape of a peculiarity of engine engraving; namely, an epicycloid in an oval, having equal spaces in all parts of the path of the epicycloid. A little consideration will render it evident, that the difficulty lies in avoiding the crowding of the device at the two ends of the oval. Mr. Whiting has so far successfully carried out this idea, and we understand that he is about to publish a specimen of the compound design. We have an impression of one of his plates by us, which may be seen at our office. It appears to present very great difficulties in the way of imitation, but we are by no means certain that it will confer greater safety than is attainable by other arrangements.

EXHIBITION OF PICTURES AT THE ROYAL ACADEMY.

(From our London Correspondent.)

One of the great events in a London season is the opening of the Exhibition of Paintings in the apartments belonging to the Royal Academy. The walls of six rooms are covered with pictures and drawings, and another room is occupied by works of sculpture. The mere effect to the eye of one who has never seen anything of the kind before, as he walks from one end to the other, is gorgeous in the extreme. The world without is forgotten, as he gazes with astonishment upon the glowing colours that everywhere surround him. Fortunately, the price of admission is so trifling, that low as well as high may give themselves at least one meal at an eye-banquet so dainty; but the pictures are so numerous, and the excellent ones are so attractive, that few people will be content with a single visit. But it is not merely as an agreeable place for passing the time that the Exhibition is to be looked at. No doubt it does much good in disseminating a love and knowledge of art amongst the thousands who annually visit it, and it shows at once to the people of England, as well as to foreigners, the state of art amongst us at this day. Of course, artists send their best pictures here; therefore we have the opportunity of comparing the best effort of one man with the best work of another. Thus the genius of artists can be properly ranked by the public, and thus the eye of the people is educated by the comparison, to distinguish, on true principles of taste, the good from the worthless. On artists themselves, again, this knowledge of the ordeal their works have to pass through must have a beneficial effect. A man strives the more as his competitors are numerous. Besides, by this means, a young unknown artist of merit may prove himself worthy of notice, the cheering influence of applause may stimulate his powers to fresh efforts, and he may convince the world that if he is not rated amongst the great few, he ought to be. The opening of the Exhibition is always looked forward to with lively feelings—of anxiety on the part of the artist—of curiosity on the part of the public. Whether one maintains his ground as head of the department in which he has long excelled, or another is pressing hard upon his heels; whether an old favourite has produced anything like the picture that excited so much hearty praise in last year's Exhibition, or some new candidate for fame will show us nature under a new aspect, or enlarge the domain of pictorial fancy—these are questions which the Exhibition itself must answer; and consequently the opening day is a day long expected. Those acquainted with the Exhibition in days gone by, remember the curiosity of the public to know what Sir David Wilkie had been doing in the past year; and there is a good deal of the same feeling at present as to Edwin Landseer's paintings.

It may perhaps interest our readers to give a short description of the principal contents of the Exhibition of 1848. But nothing beyond a few cursory remarks upon those pictures which have struck us as being the best must be looked for; detailed or profound criticism is out of the question. It seems to be generally agreed that, in the department of historical painting, Cope's "Cardinal Wolsey," painted for Prince Albert (No. 11), is the leading work. It is certainly the finest picture of the artist that we have seen. The period in Wolsey's life selected for delineation, is that when "an old man, broken with the storms of state," presents himself at the door of Leicester Abbey, and craves "a little earth

for charity." Borne between the arms of two attendants from off his mule, he faintly extends his hand to the reverend abbot, who, standing with his monks on the steps of his convent, receives the wretched cardinal with a countenance of deep commiseration. Behind are the stout bare and armed men who arrested him. The heads of the monks are well drawn and individualized; the harsher features of the men are agreeably relieved by a female face amongst the crowd, of the type Cope loves to paint—fair, soft, and somewhat unmeaning. The colouring is rich, the attitudes natural and easy, with the exception of the man standing in armour on the left. The figures on the right seem to us much better drawn than those on the left, but we must regard the whole as a fine addition to his Royal Highness's collection. Cope's style is, to our mind, far more agreeable than the hard scenical painting of Maclise, where the eye has no rest, where every part is forced upon it, and demands being seen.

Immediately above this hangs a landscape by G. A. Fripp (No. 12), "Mont Blanc," a work of wonderful power. You look across a deep valley, seeming to be little else than a gigantic gully, to the rocks which girdle the monarch of mountains, and carrying the eye up and up, over beds of snow and glacier, till it reaches at last the loftiest peak. The spot where the spectator is supposed to be standing is a road which winds along the breast of the mountain over against Mont Blanc. Some Savoyards with their cattle are coming along it, and figures may be traced to a great distance. It crosses a stream that pours down from the heights above; here and there a pine-tree or two are near it, till finally it is lost behind a projecting screen. The snow lying upon the ledges of rock on the lower parts of the alp, the reaches of the valley, the views over upland pastures, the mists floating about the flanks of the peaks, and the management of the perspective, are entitled to the highest praise. The picture is so like an actual view of nature—it is finished with so much care, truth, and grandeur of effect—that it does the artist infinite credit, and ranks him henceforth amongst our best landscape painters.

In the same room is Stanfield's "Amalfi" (No. 217), a view of a decayed town on the Italian coast, painted in the artist's finest manner. Amalfi (says Gibbon) fell after 300 years of prosperity; but the poverty of one thousand fishermen is yet dignified by the remains of an arsenal, a cathedral, and the palaces of royal merchants. The view is from a heaving ocean to the rocks whereon these buildings are perched. They are seen on the margin of the water, climbing up the rifts and crowning the pinnacled precipices. The background is formed by a mountainous ridge, wrapped in snow. Some boats and sailing vessels throw life and animation into the scene, which is rendered with an inimitable breadth of style and poetical grandeur. The people of Amalfi at one time circulated a coin familiar to all nations, and their maritime laws were adopted wherever commerce extended. They built many churches in the east; they founded the celebrated order, afterwards known as the order of the Knights of Malta; and one of their citizens invented the compass. Stanfield, who excels in marine pieces, has contributed four other pictures. His pictures are all characterized by a light, airy touch; there is plenty of space in his representations, no suffocating plenum, but all is free, clear, and fresh as nature herself. He combines the excellencies of Vandervelde and Canalitio, and has some of his own which both of these painters wanted. Of the four, we suppose the view across the Rhone at Avignon (No. 166) will be considered the best. Here the ruined bridge of St. Benezet, originally consisting of nineteen arches, stretches into the rapid stream. Some picturesque buildings are upon it, and many houses are scattered amongst the trees on the opposite shore. In the foreground two men are employed in unloading a barge of felled trunks.

J. D. Harding has sent a brilliant Italian landscape (494), the "High Alps near the Lake of Como;" and D. Roberts has three pictures well deserving attention. No. 252 is the interior of a Church at Antwerp, with a perspective mathematically correct. No. 201 is a view of Ruins in Egypt, in which the sunbeams, striking through a thick sultry atmosphere upon tanks and buildings, men and mountains, are nicely rendered; and No. 329 is "Mount St. Michael," on the coast of Normandy, a detached rock, crowned with religious edifices that shoot into the sky, and with houses at the base.—It is not often that we meet with sketches of Norwegian scenery in our galleries; they are far more frequently to be found in France and Germany. No. 473, however, is a scene, by W. West, between Bergen and Christiana, and, though in a low tone of colour, very truthful and effective. A clear stream pours along between high and nearly bare rocks. The eye is well carried up the windings of the glen, and there is a tall precipice that rises grandly in the middle distance.—From these scenes in foreign lands, we may turn to home delineations. To Lee's foliage we have usually to object to the exaggeration of its green tints. He has contributed six paintings; the largest and most pleasing are Nos. 383 and 503, in which Sidney Cooper has painted the cattle. The first is a scene on the edge of a park, out of which a stream flows, and cattle have waded into it to drink. The other is amongst the Welsh mountains. A stream issuing from a ravine spreads out into a shallow; some cows are standing mid-leg in it, and there are some more cattle on the bank. The view then extends over a bare upland, to mountains still more bare, encircled with wreaths of mist; a few shrubs have crept into the gullies for shelter. The cattle in these pictures are uncommonly well painted, and light up the scenery marvellously. Of the pictures painted solely by Lee, the best is No. 88, another stream, but in this case richly fringed with trees; its bed is rocky, and above the foliage, mountains are seen. Some figures in front add to the effect, and the perspective is well managed.—Creswick has sent six landscapes, all of them clever, but none so fine as works he has previously exhibited. The best is 314, "Home by the Sands." Men and women are shown with their horses and carts travelling along the edge of the sea towards some distant hills.—Redgrave's "Skirt of a Wood" (348) is very clever, and looks like the reflection of a real scene in a convex mirror. The characteristics of the beech-tree bark, the pencilling of the foliage, and the manner in which the sky is shown through the trees, are very happily managed.—Danby's pictures are comparative failures; and Linton has not nearly equalled the splendid landscapes he has turned out in former years. His best is "Corfe Castle" (580), which ruined pile is thrown into a high angle with good effect; but the picture is too gloomily coloured.—Reinagle's "Campagna of Rome" (433) after a storm, is a fine work, and deserves inspection.

There is a large number of portraits on the walls of the Exhibition this year; but, with few exceptions, they are not excellent as works of art, and do not give any exalted idea of English beauty. Decidedly the best as a work of art is E. Landseer's "Sketch of my Father" (No. 85), a plain old man reading in a large book.—F. Grant's portraits rank next; and of these perhaps the most attractive are the "Ladies Howard" (No. 67), and the "Viscountess Pollington, her Son, and Sister" (No. 365).

Edwin Landseer's representations of animal life are, as they have always been, wondrously true and spirited. There are four of them, of which the general favourite is No. 403, a mass of snow on a Highland mountain, on which a hind, dead or dying, is stretched, whilst her fawn is sucking. Such are the simple materials of the picture which attracts crowds of admirers from the skilful execution and the pathos. No. 48 is a capital portrait of "Pincher," a terrier, a full face seen through the hole of his kennel. "Alexander and Diogenes" (No. 208) is one of those satiric touches on mankind through animals, for which Landseer is so well known. The king is an ugly white cur, strutting with supercilious airs, and attended by courtiers in the shape of lap-dogs and hounds, before a cask, where Diogenes is lying at his ease, a sly-looking dog, quite prepared to tell Alexander to stand out of the way, and let him see the sun. No. 229 is an old hack feeding quietly at a stable door, where three hounds are lying on the ground, whilst a pup is curled up on the top of a tub asleep. We need not say that all the accessories, hay, whips, &c., are carefully done.—Sidney Cooper has nothing so good as some pictures he exhibited in 1847. Still everything from his pencil deserves notice. In his cattle pieces we do not know that he has been excelled by Cuyp, Paul Potter, or any of them. The two best are No. 423, "Some Goats on a Welsh Mountain," and No. 551, "Cattle and Sheep by a sluggish stream in Kent." It has been intended to represent the distance thick with a sunny haze; but the artist has failed to accomplish his object.—Ansdell's "Battle for the Standard" (No. 585), the largest canvas in the Exhibition, is a very creditable performance for a young provincial artist.

Turning to the compositions from fable or familiar history, Frost's "Bevy of Dancing Nymphs" (No. 336) will catch and please the eye. The colouring is gay and harmonious, the figures well drawn, and the grouping highly graceful. To Leslie's "Lady Jane Grey" (No. 157), and to his other picture, "The Shell" (No. 162), we cannot give much praise. The unfortunate lady is represented by a prim quakeress.—Of Charles Landseer's two pictures, the only good one is "Mademoiselle Montpensier at her toilette, assisted by Henrietta Maria, Queen of England, and her Son."—Far superior, however, to these are Frith's pictures (395 and 591). The first represents a Country Justice in the reign of James I., seated in his hall, and hearing a charge of witchcraft against an old woman by the mother of a girl, whose health has been affected by some unseen cause. The accused is as innocent an old lady as ever hobbled on crutches; but still the evidence is clear, for the girl is ill, and who could have caused it but the ancient dame, who doubtless lived in a cottage with a cat for her only companion? The drawing and colouring are very masterly. The other is a scene from one of Moliere's comedies—three figures well finished and coloured.—H. N. O'Neil's "Catherine of Arragon appealing to Henry VIII." (No. 542) is a highly meritorious performance. Catherine kneels with uplifted hands before the inexorable king seated on his throne, her countenance full of expression, her attitude full of grace. Behind her, and in the centre of the room, is a table, at which are eccle-

siasties and officials sitting and standing. Three of the Queen's women are also present. The hues are finely contrasted, and the picture is one of the ornaments of the Exhibition. We cannot do more than refer to Luey's "Landing of the Puritans" (308), Williams' "Artists' Portfolio" (495), and Rippingille's "Beating the Boundaries of a Parish" (461), as having considerable merit.

We must find space to notice two other little pictures, and we shall then draw our hasty remarks to a close. The first is a picture by Mulready, called the "Butt" (No. 160). A butcher's boy, having delivered his tray of meat, has met with a friend, who is also in an idle humour. Luckily for the young gentlemen, two girls with a basket of cherries are in the neighbourhood, and they are forthwith pressed into the service. The butcher's boy leans against a tree and opens his mouth, whilst the other lad, having obtained a supply of fruit, aims at the orifice, but takes especial eare to miss it as often as he ean, as the stains upon the butt's face testify. The girls are seated on the ground, and, forgetting the immediate calls of business, take immense interest in the striking scene. Capital fun they think it, and so does the butcher's dog too. People may differ as to the propriety of a man with Mulready's genius employing himself upon low art like this; but there can be only one opinion about the success of the effort. The other pictnre we alluded to is Webster's "Rubber at Whist" (No. 176), no less excellent in its way. Four men are seated in due form at a table in a country kitchen, and a spectator smokes a pipe through the window. It is easy to see which is the winning party; for the expression is very cleverly rendered. The manage-ment of the light thrown from the open window upon the angles of the figures and objects is admirably managed, and the still life is capitally done. Notice how the light is shown through the cards in one man's hand.

THE WATER CEMENTS OF ENGLAND.

The term Water Cement holds good in a double sense, implying not only one which sets under water, but one which, being of a calcareous nature, is prepared for use by mixing it with water.*

The best water cements of England are the Sheppy and the Harwich cement, which are most used about London, and the Yorkshire cement is also said to be good, but of this I speak from report chiefly. They should always be designated in this manner by the places from whence they have been obtained, and not by the absurd title of Roman Cement, which serves only to mislead the ignorant, and being used alike for each, and all, and for every mixture of those cements, prevents those who are better informed from knowing what sort of cement any manufacturer of that article is offering for sale, unless they make minute inquiries, or personal observations, at his cement kilns.

These cements differ chemically from the water limes, only in containing a smaller proportion of carbonate of lime, and a larger proportion of silica and alumina in their composition, than the latter. Practically they differ from lime in several remarkable particulars.

First. The water cements will not slake at all, after being burned, boiling water having very little action upon them, and cold water none at all,† unless they be previously pulverized, by pounding or grinding them, which is therefore always done in preparing them for use.

Secondly. The fine calcined powder thus obtained, when made up into a ball with water, does not swell or go to pieces, whether in air or if put immediately afterwards into a basin of water, but sets or hardens without any perceptible alteration of its bulk, under water, in an infinitely shorter time than the best limes do in air. The first of those properties was no doubt the cause which prevented men in this country from discovering the nature and use of the cement stones on the South-East coast of England, until within the last forty years, when the light of Chemistry began to be more generally applied to the practical arts.‡ The second property is that which renders them particularly valuable, under situations and in circumstances where the best limes would fail.§

Thirdly. Cement is always weakened by the addition of sand, whereas every kind of lime is improved by it, so that in all cases lime mortar made with the proper proportion of sand, is much stronger than lime putty.

Fourthly. When cement powder, whether net or with the addition of sand, is mixed with water, for the purposes of Practical Architecture, it must always be used before it becomes warm, after which process it must never be disturbed, so that any portion of it that could not be used immediately must be thrown away; whereas mortars made of all limes, and more especially of the pure limes, may be disturbed, and if not used immediately, they may even be remixed by adding more water, without materially injuring them.‖

To analyze a cement stone or any other compound mineral accurately, so as to obtain the precise proportional weight of each of its component parts, is not only one of the most difficult operations of Practical Chemistry, but demands much more time than Architects, Engineers, or Builders, in full employment, can spare. I beg, therefore, to suggest the following simple and satisfactory mode of proceeding in testing a stone supposed to be a water cement, which ought of course to be of a bluish grey, or brown, or of some darkish colour, as white indicates pure limestone or gypsum.

From their containing silica and alumina, which are the component parts of clay, the natural cement stones, on being touched by the tongue, indicate sensibly the presence of clay, which is also detected by the smell after wetting them. They only dissolve partially in diluted acids, leaving a more copious sediment than any of the lime stones.

The first test, therefore, is to pour a little diluted muriatic or nitric acid into a wine glass, and drop a fragment of the stone into it. If no action take place, it is neither a lime stone nor a cement, but if it effervesce and fall to pieces with a muddy sediment, it is probably a water cement.

To ascertain this point, break the stone, if necessary, into compact fragments not exceeding one inch and a half in thickness, and put two or three of these into a common fire-place, first heating them gradually, that they may not burst into too many small pieces, and keep them exposed to a full red heat for about three hours. At the end of this time, take one of your specimens out of the fire, and put a small fragment of it into a glass of diluted muriatic or nitric acid. When the stone is burned enough, that is, when all the carbonic acid gas has been driven off by the heat, no effervescence will take place in the acid. A moderate effervescence will show that it is a little under-burned, but violent effervescence will show that it is very imperfectly burned, and it should therefore be put into the fire again.

At the same time great care must be taken not to overburn the cement, which is always injured, if not entirely spoiled, by excess of heat. When moderately overburned, its colour is changed to a much darker tint than ought to belong to it, which may easily be judged of after a few trials, and which is a proof of incipient vitrification; for by excess of heat all the natural cement stones may be fused into a dark-coloured glassy substance, resembling the volcanic product called Obsidian.

If, therefore, the calcined cement stone do not effervesce with acids, and if at the same time its proper colour be not changed to a darker one on taking it out of the fire, these circumstances prove that it is properly burned.

In this case, you must take your specimens and pound them in a mortar, until they are reduced to the state of impalpable powder. To ascertain whether the calcined cement be sufficiently pounded, take a pinch of it between your finger and thumb, and rub it backwards and forwards. If it feel gritty to the touch, so that after having rubbed away the finer parts a number of small solid particles remain, let the whole of the pow-

* In contradistinction to *Oleaginous Cements*, such as *Mastich*, which is a mixture of litharge, stone-dust, and linseed oil, and to *Resinous Cements*, such as the *Mineral Fusible Cement*, proposed by Mr. Fitz-Lowitz, and experimented upon by Lieutenant-Colonel Sir J. M. Frederick (then Captain) Smith, of the Royal Engineers, in 1829, who reported that when prepared for use by melting it in a cauldron over a fire, and mixing it with twice its own weight of sand, it appeared stronger than the Sheppy or Harwich cements, though the latter was used net. But it was then about 50 per cent. dearer than the natural cements, and in most situations its inflammability would be a strong objection against the use of it, for I found that it would burn even in the flame of a candle.

† I have found by repeated experiments, that when cement from the kiln is sprinkled with boiling water, the pieces usually crack or split, and much more heat is produced than is due to the temperature of the water, so that all the symptoms of incipient slaking are observable; but this process seems suddenly to stop short, for the cement does not fall down into a fine powder, and thus the heat goes off without the fragments losing their solid form, at least within the space of two days, after which period, not anticipating any farther change, I have always thrown them away.

‡ The properties of the Sheppy cement were first discovered by Mr. Parker, who took out a patent for the sale of it under the title of Roman Cement, but which from him as the discoverer, was at first often termed Parker's cement. Afterwards Mr. Frost, whose more recent labours I have before noticed, discovered that the stone on the beach near Harwich, belonging to the Ordnance Department, had similar properties. The Yorkshire cement is sometimes termed Atkinson's cement, from the name of the architect who introduced it in London, or Mulgrave's cement, from the Earl of Mulgrave. It appears to me that the names of all water cements should be derived from the localities where they are obtained, which is always done in respect to limes. The use of such cements, a recent discovery first made in this country, was entirely unknown, not only to the Romans, but to all other nations, until Mr. Parker's time.

§ A joint of brickwork laid in net cement becomes harder in half an hour, than the best mortar made of Dorking or Halling lime would be in six months, or even more. Recently, on inspecting a fine brick building in Southwark, now ready for receiving the roof, I observed that all the joints of the vaults and of the flat arches over windows, which were laid in cement mixed with sand in equal parts, were perfectly hard, resisting the edge of a shilling, whilst the joints of the mortar, which was no less good of its kind, being made of the best Halling lime mixed with clean river sand, were so soft, even in the lowest and first finished parts of the walls, that the edge of a shilling raked out any part of them with almost as much ease as if they had been composed of sand alone.

‖ Notwithstanding this distinction between cement and limes, the properties of all calcareous stones appear to me to be so analogous, that I cannot help thinking that it is possible that cement mixed with a moderate quantity of sand, and made up with water into a heap, and left for some hours, or even for some days, might bear remixing, and that in process of time it might even set, like a heap of remixed lime mortar. But as the chief or only advantage of cement over such limes as the blue lias or Aberthaw, is in its instantaneous setting, and as I conceive that remixed cement will probably set, if at all, more slowly than lime mortar, the rule never to disturb cement that has been used, and never to use cement that has been long mixed, should always hold good in practice.

der be ponnded finer, until, on repeating the same process, no such grittiness is perceptible, and no such particles remain. This is of the greatest importance, for I have ascertained that the best cements, both natural and artificial, are very much deteriorated, if imperfectly ground or pounded after calcination.

The next process is to take a small quantity of the fine powder, and mix it up with a moderate quantity of water, by means of a spatula or strong knife, upon a slate or porcelain slab, and knead it into the form of a ball by turning it between the palms of the hands. It will then soon become warm; and if it be a good water cement, it will not only set or harden in the heating, but if put iuto a basin of water, it will continue hard, and even become harder in the basin. A ball of good cement will set under water, even if put in quite soft and before it becomes warm; and in this case it makes the water dirty by throwing off a little scum from its own surface. It is better, therefore, to wait, till after having attained its greatest warmth, it shall have begun to cool a little, before you put it under water.

The setting of snch cement balls may be much retarded, even to double the usual period, or more, if you mix the same calcined powder with a larger quantity of water, so as to form a thin or liquid instead of a stiffish paste; and in this case the heat thrown out will be diminished in the inverse proportion of the time required in setting: but eventually the slow setting ball becomes quite as hard as the others. I have ascertained by experiment, that one-fourth part of water to one part of cement powder by measure, is necessary for making a stiffish mixture, whilst one-half measure of water to one measure of cement powder produces a very thin one. Between these extremes the proper proportion of water appears to lie. Less than one-fourth would not suffice to make up the whole of the mixture into a paste, whilst more than one-half would be inconvenient or injurious; for cement powder may be spoiled, or as it were drowned, if stirred up in a basin or bucket with excess of water; but this can never occur in practice, nor is any measurement of the proportional quantities of cement powder and of water either usual or necessary; for the expert bricklayer's or plasterer's labourer always mixes those ingredients together to the proper average degree of consistency, with very great accuracy, by the eye alone. During the process of setting, experimental cement balls always throw out vapour, which may generally be seen rising from them as long as the heat continues, and which moistens the surface of any dry substance on which they may be laid.

The Sheppy cement stone is usually found in houlders or round nodules, and when dry is of a light-brown colour. The Harwich cement stone is obtained in larger masses, and is of a dark bluish-brown colour. When properly burned, the former is of a light-brown, the latter of a nut-brown colour. When the calcined powder of each is mixed with water for use, both mixtures are brown, but the former is of a much lighter tint than the latter, which approaches to blackness.

Since cement from the kiln will not slake even with water, much less by the action of air alone, it might be preserved in this state for a long time in a dry room, as I have proved by experiment; but calcined cement being of no use until it is pulverized, this is always done at the mill of the manufacturer, to save the necessity of every purchaser providing himself with an apparatus for grinding it. This process, which enables water to act upon cement, makes it also subject to the action of the atmosphere.

After calcined cement powder has been mixed up with water for use, it recovers in time the whole of the carbonic acid gas driven off by the fire. Hence the cement used for the purposes of Practical Architecture, like the lime in mortar, is brought back, but much more quickly than the latter, to the same chemical state as in the original stone. Hence also a fragment of old cement from a building will partially dissolve in the dilnted acids, leaving a residue; and on reburning old cement and pulverizing it, the calcined powder thus obtained will be quite as good as that from the natural stone. Cement powder exposed to air, especially if damp, also gradually recovers the carbonic acid gas previously driven off from it; and whilst this process is in progress, it is injured, and eventually spoiled. For this reason the cement powder prepared for sale is always preserved in casks or sacks. When cement powder, damaged by exposure to air, or from any other cause, has become too *stale* for use, it may be converted into good cement hy reburning it, the practicability of which may be ascertained by burning some stale cement powder in a crucible in a common fire-place. But if any considerable quantity of damaged cement should require to be restored in this manner, as it could not conveniently be burned in a kiln whilst in the state of powder, it would be necessary first to mix it up with water into balls or lumps of a convenient size, which, if allowed sufficient time, will probably set so far as not to fall to pieces. If, however, the cement powder should be too stale for this purpose, let a small proportion of fine clay, not exceeding $\frac{1}{10}$ part by measure, be added to it, in making these lumps, which will cause them to hold together in the kiln, without materially injuring the quality of the cement. It would not be worth while to take so much trouble in this country; but the knowledge of this expedient may perhaps be useful in some of the British colonies, where cement is only obtained by importing it from England.—*Major-General Pasley on Cements.*

RECENT PATENT.

MORISON'S IMPROVEMENTS IN APPLYING POWER.

The improvements embodied in this patent are the invention of Mr. James Morison, of Orchard Street, Paisley, well known as an ingenious improver of the Jacquard machinery. They relate—First, to certain arrangements of machinery or apparatus for the propulsion of wheeled carriages or conveyances on common roads or railways, which arrangements of machinery are also applicable to the propulsion of boats, and as a working apparatus for general machinery. Secondly, to certain modifications in the wheels of carriages or other conveyances for common roads, whereby the said wheels are enabled to carry their own rails, thus facilitating the passage of the said wheels over uneven surfaces. Thirdly, to an improved propeller or feathering float-board, for paddle-wheels of steam or other mechanically-propelled vessels, which said propeller is also applicable as a wind-vane for horizontal and vertical wind-mills. Fourthly, to certain apparatus for the propulsion of certain modifications of carriages in water. Fig. 1 represents a side elevation of a carriage adapted for travelling upon common roads, capable of being worked or propelled by one person, riding or being carried therein; and fig. 2 is a plan of the same. The main framing of the carriage is composed of two horizontal beams, which are curved, as shown in the plan, fig. 2. These beams are connected by means of back-pieces, with two similar beams below. In these figures the framing is shown as if deprived of its covering (which covering may either be made of wood, cloth, or other suitable material), for the purpose of representing clearly the internal propelling mechanism. The shaft or driving-axle of the wheels is carried by two bearings, fixed on the tops of two pillars, bolted on the inside of the main framing of the carriage. The driving-axle is of a square section between the bearings; immediately on the outside of which, keys or feathers are attached to it. On these keys the sliding halves of two ratchet-clutches are fitted. These clutches are adjustable in and out of gear with the ratchet-ends of the bosses of the wheels by means of spring-levers. The lower ends or spring portions of these levers are attached to the outside of the framing, their upper ends beneath the handles being formed into rings surrounding the clutches, and projecting pins being formed on these rings for the purpose of moving the said clutches, by means of grooves cut on their peripheries. The driving-wheels are arranged to run loose on the ends of the driving-axle, the inner ends of the bosses being serrated, and fitted to the serrated or ratchet-ends of the sliding-clutches. By this arrangement, it will be seen that the driving-wheels may be at any time disconnected, so as to move independent of each other and of the driving-shaft, simply by drawing back the clutches. The seat of the rider, one or more of which seats may be fitted to one carriage, is moveable in a vertical direction, being guided by the two metal or other spindles bolted on its under side, which spindles work in guides attached to the framing of the carriage. This seat is adapted for communicating motion to the carriage by a bar which is bolted beneath the seat at the front of the driving-shaft. This bar has attached to its lower extremity a stout strap of gutta-percha, leather, or other suitable material, which is passed over the centre pulley of the three which are fast on the driving-shaft. These pulleys are made of wood or metal, and are covered on their peripheries with a layer of gutta-percha, or a composition thereof, which layer is serrated or formed like a ratchet. The under side of the strap is also serrated for a portion of its length, to fit the serrations or ratchet-teeth of the pulley. The seat of the rider is thus rendered available for acting by the weight of the rider upon the driving-wheels, so as to cause them to revolve by the action of the serrated or tooth-strap upon the pulley during the descent of the seat. When the seat is permitted to descend by the weight of the rider, the teeth of the strap hold on those of the pulley, which is thus turned round a distance equal to the length of the stroke of the seat; and when the seat is again raised, as will be hereinafter shown, the angle of the teeth of the pulley and strap permits of the slipping back of the latter over the teeth of the pulley, in order to take a fresh hold upon the pulley when the seat again descends. A short elastic band is attached to the back end of the strap and to the fixed cross-bar of the frame, for the purpose of acting by its elasticity in bringing back the strap at each rise of the seat. The second pulley on the driving-shaft is also actuated by a serrated band, which is attached to the end of a treadle, which treadle is hinged at its contrary extremity to a

bar of the framing of the carriage; the third pulley is similarly fitted with a serrated band, which is acted upon by a bent lever. This lever works on a centre-piece, carried by the bottom framing of the carriage, the bent portion extending back towards the driving-shaft. This end of the lever is linked by a short connecting-piece to one end of a transverse lever passing across the framing of the carriage, its contrary end being arranged to oscillate upon a fixed stud on the framing. To this lever the extremity of the band of the third pulley is attached; thus, when the lever is pulled by hand in the direction of the arrow, the depression of the transverse shaft will draw down the strap of the pulley, causing the latter to revolve. In this manner, the whole of the pulleys are employed in causing the driving-wheels to revolve. In order to elevate the seat of the rider, and the treadle, after each depression, an additional apparatus is employed in connection therewith. A light shaft is carried loosely in bearings attached to a cross-bar passing across the framing immediately under the driving-shaft. This shaft carries a small cylindrical box, containing a coiled spring, one extremity of which is fastened to the shaft, the other being connected to the interior of the box, which is thus arranged to act like the main-spring barrel of a watch. To the exterior of this box is attached a short lever, the end of which is formed into a segment of a circle as seen in the elevation, fig. 1. To this segmental lever a strap or band is fastened, passing downwards to the end of the treadle, to which it is fastened. At each depression of the treadle, the spring contained in the box is coiled up to a certain extent, so that upon the release of the treadle from the weight of the foot, it is brought up by the tension of the spring winding up the band of the lever. The same shaft and spring are also employed for raising up the seat of the rider by two conical pulleys formed like the fusee of a watch, and fast upon the shaft; straps are fastened to the larger ends of these pulleys, which straps, after passing round the pulleys, are attached to a cross-bar upon the lower extremities of the guiding-spindles of the seat. The pulleys being fast on the shaft, the spring in the box acts upon them so as to wind up their straps, and thus raise the seat after each depression, as before explained with reference to the treadle. The action of propulsion is then as follows:—The rider or passenger having placed himself on the seat, the weight of his body then presses it down, and by means of the apparatus described, the seat acts on the central pulley on the driving-shaft, and causes the wheels to revolve in the direction indicated by the arrow; when the seat is at the end of its downward stroke, the operator or rider removes his weight from the seat by pulling towards him the lever, by which he raises himself up at the same time to nearly a standing position, and throws his weight upon the treadle, which acts

Fig. 1.

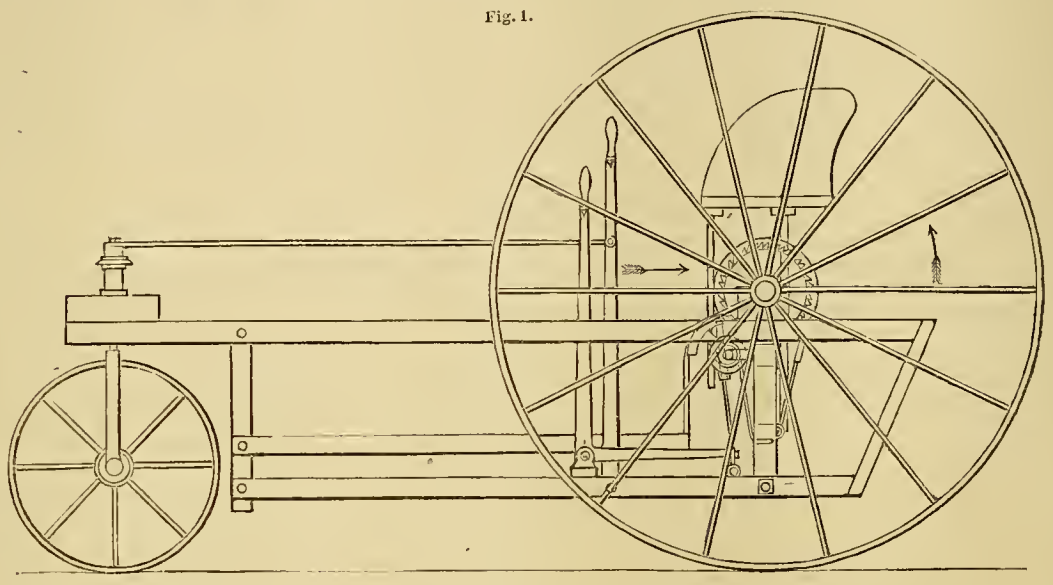
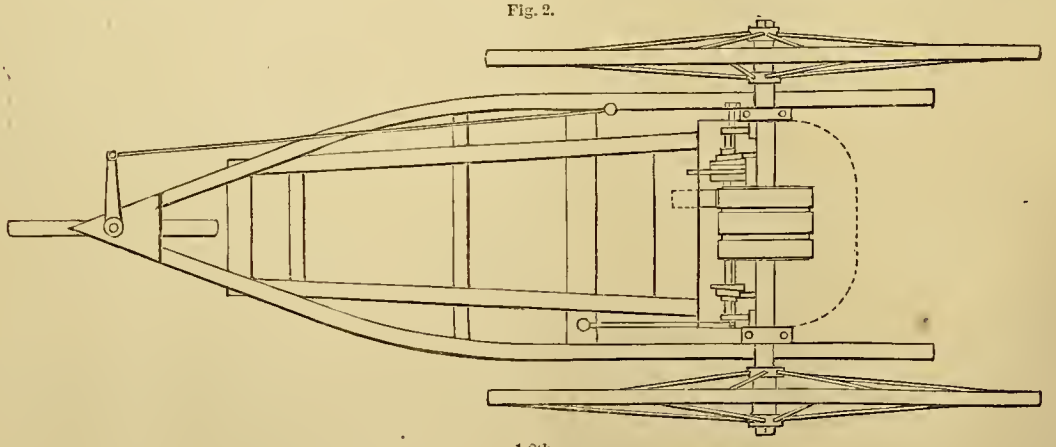


Fig. 2.



upon the first pulley, while the motion of the hand-lever, depressing the transverse lever, acts similarly upon the third pulley, so that the three pulleys act in concert in urging round the driving-wheels. When the weight of the rider is removed from the seat to be applied to the treadle, the seat immediately rises to the top of its stroke, being lifted by the coiled-spring in the box, which turns the shaft, and winds up the straps of the cone pulleys—the relative diameters of the opposite ends of these pulleys being proportioned to the varying tension of the spring at different periods of its action. As the rider's seat and the treadle are independent of each other, they may be worked together or separately, or in different sequence, as desired. Thus, if a slow motion only is required, or where much power is not applied, the hand-lever alone may be employed, the rider remaining seated, as the seat will not have any motion; or the treadle may be used alone. A modification of this method of propelling is represented, in which the driving-strap is not serrated, but has attached to it a separate catch or detent of wood, metal, or other

suitable material, which catches; or a series of them may be employed instead of the serrations on the strap. In order to assist the carriage in passing curves, the clutch boxes of the driving-axle permit of the disconnection of either of the wheels. The sliding halves of the clutch-box, being formed with ratchet-teeth on their outer end, and acting so as to hold in gear with the bosses of the driving-wheels when going forward, it is evident that, when the carriage passes a curve, the outer wheel will revolve independently of its axle, as the ratchet-teeth upon its boss will slip over those on its sliding-clutch. The hand-lever for guiding the carriages is carried upon a fixed stud on the lower part of the carriage-framing; a connecting rod passes from it to a short lever fast on the upper end of the forked-guide of the guiding-wheel, which guide is steadied and supported at its upper extremity by the metal socket fast on the top frame. The lower portion of the guide lever is thin and elastic, and is kept pressed up against the inside of the framing. The lever carries a small adjusting-pin, fitting to the holes in the curved plate adjusted on the frame, so that the guiding-wheel may thus be set at any angle to suit the direction of motion required. Although this carriage has been described as worked by one person only, it is evident that two or more persons may be employed in giving motion to it by fitting up additional seats in it. As a means of economizing power in the working of carriages on this principle, the patentee proposes to employ compressed air as a subsidiary propelling power; to accomplish this, he proposes to adapt an air-pump, to be worked by a crank on the axle of the driving-wheels, or other suitable means; such pump to be employed in forcing air into a reservoir fitted on the carriage. In descending inclines, such a pump being put in action will absorb the superfluous power occasioned by the gravity of the machine, by forcing atmospheric air into the reservoir at a high pressure; the air thus compressed will be available for assisting in the propulsion of the carriage when required, by acting on the pulley and straps; or a modification thereof may be employed for transmitting power to machinery in general, such as the driving of lathes, saws, or the propulsion of boats. The pulley described as formed with ratchet-teeth, may also be formed simply with recesses for the reception of the projecting teeth of the driving-hand. In cases where the motion of the driving-band is not required to be reciprocatory, the ratchet form of tooth may be dispensed with, and plain teeth substituted.—The patentee also shows an elevation and plan of a portion of a carriage-wheel carrying its own rails, for the purpose of enabling it to overcome the difficulties caused by the unevenness of the surface of common roads. A shallow groove is formed round the periphery of the wheel, into which a series of straight and flat bars of metal or other suitable material are placed, being retained in their position by conical or triangular projections, which are fast in the centre of each bar, and are passed loosely through suitable holes cut in the periphery of the wheel. A spiral spring is attached to each of these projections, connecting them with the nave or other fixed portion of the wheel; the rails are all dovetailed into each other at their extremities, so that no one of them can be released from acting in support of the wheel, until the succeeding one has come into action. As the wheel rolls over any obstruction or hollows in the road, the rails successively form inclined planes, upon which the wheel rolls, thus assisting its passage over any obstructions; each rail, as the wheel rolls, turns slightly upon the central projection, in accommodating itself to the varying point of pressure of the wheel—the springs being for the purpose of allowing this motion, and for retaining the rails close up to the periphery of the wheel. Although a series of spiral springs is applied for the purpose of retaining the rails, yet it is obvious that elliptical or other springs may be used.—The improvements in float-boards or propellers, for steam or other mechanically-propelled boats, mainly consist of a float-board with adjustable vanes, which may be so set as to enter the water edgeway, and, when arrived at the point of action, are turned so as to oppose their flat surface to the water. The patentee proposes to fit up carriage wheels with float-boards on this principle, so that when the body of the carriage is made water-tight, it may be employed as a mechanically-propelled boat for crossing rivers or navigating canals.

The claims are—First, the arrangement of machinery or apparatus employed for the propulsion of wheeled carriages or other conveyances on roads or railways, and of boats and other machinery as described with reference to figs 1 and 2. Secondly, the peculiar modification of carriages or other wheeled conveyances, whereby the wheels of such carriages or wheeled conveyances are enabled to carry their own supporting rails. Thirdly, the propeller or float-board with jointed vanes for paddle-wheels, which float-board is also applicable as a float for water-wheels, and as a wind-vane for wind-mills. Fourthly, the application of ratchet-pulleys and serrated straps, made of gutta-percha or any composition thereof, for the propulsion of machinery, as described in in reference to figs 1, and 2.

Patent sealed, July 28th, 1847. *Specification enrolled, January 28th,* 1848. *Drawn by* William Johnson, *Patent Office, Glasgow.*

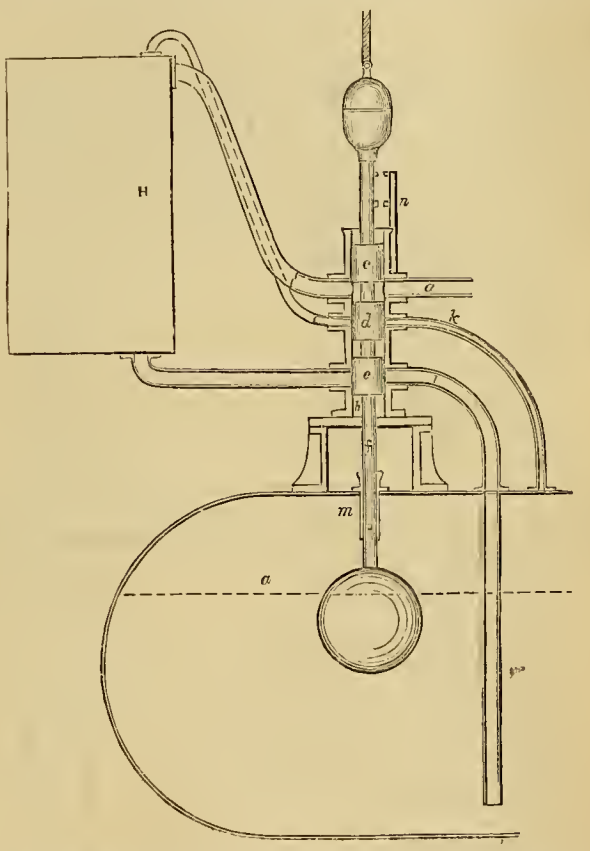
No. 3.

REGISTERED DESIGN.

AUTOMATIC WATER-FEEDER, GUAGE, AND ALARUM FOR STEAM BOILERS.

Registered for John Crichton, 44, *London Street, Glasgow.*

The annexed figure represents a sectional elevation of a self-acting arrangement for affording a regular supply of water to steam boilers, and for giving an immediate alarm should any deficiency occur. On the top of the boiler, *a*, are placed two brackets carrying an open cylinder, *b*, fitted with three solid pistons, *c*, *d*, and *e*, placed at equal distances from each other, the whole being carried by the rod, *f*, of the ball-float. The supply pipe for the feed water is shown at *g*; the water passes from this pipe through the cylinder, *b*, and out by a pipe on the opposite side to the top of the cistern, *h*, which may be placed at any convenient distance or position above the level of the boiler. As represented in the figure, the



water in the boiler is supposed to be at its proper working level, and the feed-pipe is in direct communication with the cistern, *h*; but as the level in the boiler subsides or lowers, the descent of the ball-float brings down the whole of the pistons in the cylinder, *b*. The upper piston, *c*, shuts off the supply to the cistern, *h*; the middle one, *d*, descending below the port of the steam pipe, *k*, of the boiler, opens a communication between it and the top of the cistern; and the lowest piston, *e*, opens, in like manner, a communication between the bottom of the cistern and the pipe, *l*, which passes nearly to the bottom of the boiler. In this position, the steam admitted upon the surface of the water in the cistern, balances the pressure proceeding from the boiler feed-pipe, *l*, and the water in the cistern then falls or passes, by the latter pipe, into the boiler by its own gravity. This supply then raises the ball-float, when the pistons return to the position shown, and the feed to the boiler is stopped. On referring to the engraving, it will be seen that the arrangement of the cylinder ports is such, that the feed-pipe to the boiler is half open before the steam is permitted to enter the cistern, thus affording a free water-way to the boiler.

The piston rod is hollow until within a short distance above the ball-float, where it terminates in an opening cut in the side of the rod. Should the water in the boiler get too low by any accident, the aperture in the side of the hollow rod, as seen at *m*, comes below the steam-tight collar in which it works, when the rush of steam up the hollow rod acts upon

the whistle at the top, and gives the alarm. The piston rod serves also as an index or guage for the water in the boiler, two projections being fixed upon it, to correspond with similar projections carried by the top of the cylinder at *n*. The top of the whistle has an eye formed upon it, to which a cord may be attached, and conveyed to any place couvenient for the engineman, so that, in the event of any stoppage in the supply of water to the feed cistern, the pistons may be thus raised and lowered to allow the cistern to be filled and emptied until the proper supply is given to the hoiler, when the foot will again act alone.

The parts in this apparatus which are not new are the whole of the parts separately considered, hut the form in which they are combined as a feeder, guage, and alarum, is registered as new and original.

MARINE MEMORANDA.

THE IRON STEAMER "FOYLE."

This steamer, built and engine-fitted by Messrs. Caird & Co., took her place on the station between Liverpool and Londonderry, in the service of the North West of Ireland Union Steam Navigation Company, on the 26th of April last. She is intended to ply in conjunction with the "Maiden City," carrying passengers, goods, and cattle. On her experimental trip on the 15th of April last, she performed the distance between the Cloch and Cumhrae lighthouses—15 miles—in one hour and four minutes, her draught of water forward being 8 feet; aft, 8 feet 6 inches; engines making 21½ revolutions. She is schooner rigged; has one main and quarter deck, three masts, stauding howsprit, and full female figure-head; mock quarter galleries, square sterned, and clinker built, with a clipper bow. Her main details are as follow:—

Length on deck	196 feet.
Breadth on ditto at midships	25 "
Depth of hold	16 "
Length of quarter-deck	44 "
Breadth of ditto	26 "
Depth	2 "
Length of engine apartments	55 "
Tonnage—hull	761 tons.
Quarter-deck	34 "
Contents of engine apartments	259 "
Register	535 "

Her engines are oscillators; the condenser is situated between the cylinders, and carries on its top a wrought-iron lever, connected to a central crank on the paddle shaft, for working the air-pumps, placed fore and aft the condenser.

Nominal power of engines	372	horses.
Diameter of cylinders	5 ft.	8¾ inch.
Length of stroke	6	6
Diameter of air-pumps	3	6
Diameter of cylinder trunnions	2	1½
Length of ditto	0	8
Length of steam ports	1	11⅞
Depth	0	4⅝
Diameter of large eyes of cranks	2	1¼
Length	1	2 9/16
Diameter of small eye	1	5⅜
Length	1	0⅝
Breadth of web	1 5⅞ to	1 7½
Thickness	0 8⅛ to	0 8⅜
Length of air-pump side rods	3	6¼
Centre to centre transversely	1	1⅜
Ditto guide-rods	2	3
Bucket-rod to plungers	1	7¼
Guide-rod to ditto	0	6 3/16
Ditto to side-rods	0	6¼
Diameter of side-rods	0 3½ to	0 4½
Ditto of plungers	0	8
Ditto of guide-rods	0	2⅛
Ditto of bucket-rods	0	4⅜
Air-pump side-rods, diameter of journals	0	3⅝
Ditto, length of ditto	0	4⅜
Piston-rod cotter-hole for clutch, length	0	7
Ditto, breadth	0	1⅝
Depth of tapered part in clutch	1	6½
Crank-shaft journals, diameter outer end	0	9
Ditto, length	0	10⅞
Cycloidal paddles, extreme diameter	27	0
Ditto ditto, effective	26	5
Length of floats	8	6½
Breadth	2	3½
Number of arms from centre	24	
Sets of ditto	3	

Two tubular boilers, fired fore and aft, with three furnaces at each end, twelve in all.

Length of boilers	16 ft.	1½ inch.
Breadth of ditto	9	7
Height of ditto	13	10
Length of furnaces	5	0
Breadth of ditto	2	6
Height, including ash-pit	3	3
Space between boilers, amidships	2	4½
Ditto aft, end of boilers to bunkers	6	9
Brass tubes at each end	165	
Diameter, internal	0	3¼
Centre to centre	0	4⅝

Her starting-gear is a simplified modification of that of the "Euxine;" it is wrought by two hand-wheels and rack and pinion. In the hull are 13 streaks of plates from keel to gunwale, diminishing upwards from ¾ to ½ inch. Distance between frames amidships, 18 inches, diminishing fore and aft to 22 inches. Frames, $2\frac{7}{8} \times 4 \times \frac{7}{16}$ angle iron.

She was modelled by Mr. John Robertson, who has earned some reputation by the production of the models of some of our best Clyde steamers; among them may he mentioned the "Sea Nymph," "Culloden," "St. Patrick," "Tiber," "Orion," "Shamrock," and the "Euxine."

PROPORTIONS OF SHIP SPARS.

The following details of the proportions of spars, are from a set of measurements of three of the best New York packet-ships, taken by Mr. Redfield, the eminent steam-boat builder in that city:—

Length of the mainmast, $2\frac{3}{11}$ of the breadth of the beam; foremast, $\frac{4}{4\frac{1}{2}}$ of the length of mainmast; mizen, $\frac{18}{19}$ of the length of foremast; bolt-sprit, $\frac{9}{16}$ of the length of foremast, $\frac{2}{3}$ of which outboard, size in the hed, same as mainmast in the partners; main aud mizen masts, 1 inch in diameter for every 3 feet in length; the foremast same size as main-mast. Length of mast-heads half the number of feet the diameter of the partners is in inches. Length of the topmasts, $\frac{3}{5}$ of the length of their respective lower masts, of which $\frac{1}{5}$ is the length of the head; size in the cap, $\frac{1}{8}$ in inches of the number of feet in length; top-gallant masts, $\frac{9}{16}$ of the length of the topmasts, $\frac{1}{10}$ of which is the length of the head, and $\frac{1}{3}$ the number of feet in length the number of inches in the cap; royal mast, $\frac{2}{3}$ of the length of the top-gallant-mast; size at keel, half the size of top-gallant-mast at cap. Fore yard, $\frac{17}{20}$ of the length of the foremast, exclusive of the arm; main yard, $\frac{27}{30}$ of the length of the mainmast; cross-jack yard, $\frac{23}{30}$ of the length of the mizen, $\frac{2}{17}$ of each of the lower yards added for the yard arm; diameter of each lower yard at slings, 1 inch to every 3 feet 9 inches in length; fore-topsail yard, $\frac{13}{16}$ of the lower yard, exclusive of the arm; main topsail, $\frac{17}{20}$ of the length of the main yard; mizen topsail, $\frac{23}{25}$ of the length of the cross-jack yard, exclusive of arm; yard-arms of topsail yards, $\frac{3}{14}$ of the length of the yard for both arms; diameter of topsail yards at slings, 1 inch to every 3 feet 9 inches in length; fore top-gallant yard, $\frac{15}{20}$ of the length of the fore topsail yard, exclusive of arm; main top-gallant yard, $\frac{23}{30}$ of the length of the main topsail yards; mizen top-gallaut yard, $\frac{23}{30}$ of the length of the mizen topsail yard, exclusive of arm; the top-gallant yard arms, $\frac{1}{14}$ of the length of the yard for each arm; size in the slings, 1 inch to every 4 feet 3 inches in length; fore royal yard, $\frac{23}{30}$ of the length of fore top-gallant yard; main royal yard, $\frac{23}{30}$ of the length of the top-gallant yard; mizen royal yard, $\frac{22}{30}$ of the length of mizeu top-gallant yard, exclusive of the arm. Royal yard arms, $\frac{1}{16}$ of the length of their respective yards for each arm; size in the slings, 1 inch to every 4 feet 6 iuches of length, arms iucluded. Jib-hoom, outside of cap, $\frac{27}{30}$ of the outboard of boltsprit, $\frac{1}{12}$ of which is end; size in the cap, 1 inch to every 1 foot 9 inches of length; flying jih-boom, $\frac{28}{40}$ of the length of the jib-boom; pole, $\frac{8}{20}$ of flying jih-hoom; size in cap, 1 inch for 1 foot 8 inches of length; spanker-hoom, $\frac{3}{5}$ of the length of mizenmast; size at sheet, 1 inch to every 4 feet 7 inches; spanker-gaff, $\frac{18}{20}$ of the length of the boom; diameter, 1 inch to 5 feet 4 inches of length.— *Weale's Engineer's and Contractor's Pocket Book.*

REVIEWS OF NEW BOOKS.

THE YOUNG SURVEYOR'S PRECEPTOR: A Familiar Practical Guide to the Science of Architectural Mensuration. By John Reid, Surveyor. Part I., pp. 24. London: J. Basevi. 1848.

As an explanation of the bearing of this work upon the operations of the architect, we may quote a portion of the author's preface. He says —"To illustrate the system to be followed, I have considered it expe-

dient to select a first-rate building, in conformity with the 'New Metropolitan Building Act,' including detail specifications, plans, sections, elevations, and diagrams; and the entire admeasurement of the parts thereof will be found embodied in the pages of the work, precisely in accordance with the most minute and customary methods at present adopted by all the eminent measurers of the day; explaining also the mode of taking the dimensions and working them out; abstracting and completing the bills of quantities; to each item of which is affixed the prime cost value, calculated according to the current prices of materials and labour." In the number before us are three plates, representing, respectively, a plan and section of excavations of the house, plan of foundations and footings, and plan of basement.

The opening pages furnish some useful information on the general practice of measuring builder's work, and convey some practical hints for the guidance of the student in commencing his operations. The remainder of the part is devoted to the excavator's work and the bricklayer's work to the ground story. The whole of the descriptive matter bears the marks of extreme minuteness; and, as far as may be judged from this portion, we may recommend it to the notice of the young practitioner.

The Chemistry of the Steam Engine Practically Considered.

(Second Notice.)

In entering upon our second notice of this production, which we introduced to our readers last month, we shall proceed to investigate the objects and advantages of the "Patent Universal Condensing Engine," as set forth in the eight well-executed plates of the volume.

No. 1 represents complete views of an "angular-set double-cylinder direct action stationary engine of 40 horse-power." The two cylinders, high and low pressure, are inverted, and are bolted to the top of an open upright frame. The axes of the cylinders form a considerable angle with each other, and the connecting-rods from each piston are attached to the same crank; the dead points of each piston being at different points of the revolution of the crank, the plan offers an increased regularity of action compared with that of two parallel cylinders.

The condenser is placed directly above the engine, on the house-top, which is made flat to receive it. Motion is communicated to this apparatus by a pulley on the crank shaft, the band from which passes upwards to a small counter-shaft driving the vertical spindle through a pair of bevel wheels. The boiler consists of an arrangement of tubes placed vertically, and surrounded by brick-work, in which is a flue encircling the tubes. The furnace is in the interior of the boiler, the chamber for the fuel being formed by strips of cast-iron, filling in the spaces between the tubes to within two feet of the top, the gases having an outlet through the open portions of the tubes to the exterior portion of the boiler. A series of quadrangular chambers are screwed on the upper and lower surface of the top and bottom plates of the boiler, into which the tubes are fastened by ferules in the ordinary manner, thus forming a channel of communication throughout the whole tubular system. The steam is led off from the top of the boiler to a dome placed in the chimney, which stands between the engine and boiler. The chimney-damper is rendered self-acting by an air-vessel, in the following manner:—When the steam rises in the boiler, water passes by a pipe from its bottom to the air-vessel, thus compressing the contained air. When the working pressure is attained, the valve connecting the air-vessel with the boiler, is closed, and a second valve, admitting the boiler pressure above the piston of a small cylinder, is opened. The bottom of this cylinder is in communication with the air-vessel; therefore, the reaction of the compressed air is acting below the piston, whilst the steam pressure is acting above; any variation then, above or below the working boiler pressure will elevate or depress the piston, which is in connection with the damper.

The exhaust steam passes from the cylinders by a pipe leading to the top of the condenser, which it enters by a hollow socket joint; thence it is conducted by a series of radial tubes to the outer extremities of a set of radial arms, which distribute it to an arrangement of smaller vertical tubes. The whole apparatus being made to revolve, the condensation is effected by the external action of the atmosphere upon the tubes, and the water resulting from the condensation is carried off by the central hollow shaft.

The inventor states that the power required for giving motion to such condensers, does not exceed 5 per cent. of the power of the engine; and argues, that this additional power is more than compensated for by the diminished resistance upon the air-pump, owing to the absence of injection water. The remaining sheets of drawings exhibit the application of the principle to marine and locomotive purposes, with various arrangements of cylinders. In the locomotive arrangements, the condenser is carried on the framing at the front of the chimney, and is worked, along with the air-pump, by a small separate engine, placed beneath the foot-plate.

The elaborate nature of Mr. Craddock's proposed plans prevents our bestowing upon them anything like a full explanation of the ideas he has promulgated; and indeed, without the aid of the drawings, we should be at a loss to set forth the objects of the great bulk of the details. In cases where water may be scarce, the air-condenser may doubtless be applied with advantage, but we cannot see that any saving would result from its adoption in locomotives, where the space it occupies, and the additional gearing and connections required for it, can be ill accorded. Several of the designs for marine engines, both with oscillating and stationary cylinders, are highly ingenious, but we are sceptical as to the successful working of the complexities which are to be found in them. The volume is well worthy of the perusal of the professional man, who will find in it many elegancies of mechanical combination, and many originalities of construction.

CORRESPONDENCE.

ON THE ESTABLISHMENT OF A COMMUNICATION BETWEEN RAILWAY PASSENGERS AND THE ENGINE-DRIVER.

I beg leave to communicate to you and your readers, (should your space allow it), a new system of railway signals, by which to establish a communication between passengers, guards, and engine-drivers. Already this deficiency has caused many sad disasters, and will doubtless, if not removed, be the cause of many more. The schemes to remedy this evil are numerous, several of which have been described and condemned by yourself. It is a very serious thing to think, that under the present arrangements passengers are hurled along at immense velocities, and consequently with the greater danger, with the consolation of knowing that should any accident occur, either by breakage of machinery or obstruction on the road, the train cannot be stopped until it arrives at the next station; and this, because of the engine-driver not being aware of the occurrence or danger, as they have no means of making it known to him, or of requesting him to stop the train. It is to obviate these evils that I have invented new signals, the principles and arrangements of which, with the help of the rough sketches herewith, I will lay down and endeavour to explain. My arrangements are the result of much labour and much thought; my hope is, that they may be found useful.

As yet no inventor has devised any scheme capable of establishing a direct communication between the guard and driver; and I maintain that it never will be done—for how can any air-tight apparatus be adjusted and kept in order amid the bustle and hurry-skurry of a railway yard? Again, if this could be done, the passengers would still be left in the lurch; for that plan does not profess to provide a remedy for their isolation. Neither do I think, that by means of a rope or chain could an efficient communication be established, whether the rope or chain work inside or outside the carriage; because I think it could not be kept tight or in working order. I do not think it possible, in a train of carriages of the present construction, for the guard, on perhaps the 20th carriage, to be able to give the engine-driver a twitch, even were the rope fastened to his elbow. Here I suggest as improvements, that all railway carriages and trucks be connected by a joint or hook, and not by a chain; by a joint that shall be inflexible; and again, that the present railway buffers are not safe. Away with all spring-buffers—let the buffers be made strong and inflexible, and let them be united in close contact in every train; then they cannot yield—the whole train will move uniformly, as if it were a single carriage, and the disastrous effects of the carriages running into one another will be avoided. In a train of this construction no breaks except for the engine will be required; because, on the stopping of the train, the carriages being in close contact, there can be no jolting caused by the carriages running forward. All the momentum will thus be conveyed to the engine. This will always be the case in a collision at either end of the train, because, as the train forms a rigid unyielding bar, all the force of the blow will be conducted along the train, and will only cause the whole to move; provided only, the carriage-buffers be made strong enough. By these improvements, breaks could be dispensed with as well as spring-buffers, and consequently there would be a great saving of expense. Besides these considerations, the danger of the carriages running into and smashing one another would be altogether avoided. The principle is so plain, that I think it requires no further demonstration; but I trust railway companies may be induced to perform experiments to ascertain its efficiency practically. In a matter of such vital importance, no experiment with small models would be efficient; it must be tried on the real working scale. I must beg leave to say, that railway travelling may be brought to the ne-plus-ultra state of safety, by con-

structing and arranging the carriages as herein set forth, combined with the improved system of signals I am about to describe.

The plan of every guard carrying a horn has been tried and not found sufficient; it was I believe first proposed by yon. It is not sufficient; first, beeause in a high wind, and under other circumstances, its sound eannot he heard by the engine-driver; secondly and mainly, hecause the passengers cannot eommunicate either with the guard or the engine-driver. Some plan, hy whieh they are not entirely seeluded, is still wanting. This want I have endeavoured to supply by the means following:—

I conclude, from experiment and ohservation, that the sound of a bell is most suitable for the purpose of railway signals; of course I mean in carriages or trucks apart from the engine, where the steam-whistle cannot be made availahle. By the use of hells, I think an easy and quick means of communication between passengers aud engine-driver, or guard and engine-driver, may be obtained.

The plan consists of a hell fixed on the top of a passenger carriage, with a spring hammer, and two ropes attached, reaching into the interior of the carriage. These ropes hang down, one at each end of the carriage, for the use of the passengers in time of danger. It will not he necessary to have a rope in the middle compartment of the carriage; hecanse the officials mnst not let any one into that part until the end divisions are filled, hy which arrangement there will always be a passenger or passengers with the bell-rope. By the handle of this rope, in the inside of the carriage, should be written in large letters, "DANGER BELL," whieh words would apprise those travellers, who might not he aware of it, of its use. Experiment alone must decide the size of the bell; however, I suggest that it he large and sonorous, so as to be heard by the engine-driver himself under any circnmstances. I propose that trains travel slower than many of them now do, for quickness is incompatible with safety; and that there never be any very long trains, for they are not safe. Every guard upon the train must be provided with a large hand-bell, that they may communicate one with the other, and with the engine-driver, without touching the passenger hells. Here, then, is a complete and easy arrangement, hy means of which a train with ouly one guard upon the last carriage can be rendered comparatively safe. However, to increase the safety of this kind of travelling, I earuestly suggest that there be a guard to each passenger carriage. The extra expense will be but little; the extra safety will be mnch. H.

[We have printed our correspondent's remarks in full, in order to afford ourselves an opportunity of seizing upon and reviewing the different details which they embody, mainly for the reason that he is by no means alone in his ideas, every railway traveller thinking himself perfectly competent to offer *practical* snggestions upon so important a matter. His remarks upon the practical objections to all plans for the establishment of a direct communication between the guard and the engine-driver are nothing more than echoes of our own opinions, to which he makes reference. Again, practice informs us that a system of rigid connections for the carriages, and the absence of anything in the shape of buffers, would be the reverse of safe. It would be totally impossible to bind twenty carriages so compactly as to preclude the possibility of separate motion. This being the case, we see that springs are essentially necessary to soften the force of unavoidable concussions. We leave out the consideration of the injuries resulting from the passage of an inflexible train round curves of even moderate radius. Finally, we decidedly question the propriety of putting the power of stopping the train into the hands of any passenger. The late fatal accident, where death ensued from the last carriage getting off the line, certainly gives us a ease in point where this power might have prevented the casualty; but, during the whole of our experience of railway travelling, we are only aware of one other instance of a like nature; therefore, to permit any nervous old lady, or inexperienced schoolboy, to annoy and inconvenience the rest of the passengers at will, might have the effect of avoiding one easualty in a thousand; hut the bulk of stoppages thus created would, from their eauseless nature, be subjected to the constant protest of the travelling public.

The above remarks by "H." are accompanied hy three sketches of alarm bells, as adapted for fitting on the tops of carriages. We have not thought it necessary to engrave these, as the same ideas have been long ago applied to omnibuses and other vehicles. Our opinion as to the practicability of establishing a direct communication between the guard and driver hy means of a peculiar sounding instrument, as a horn or whistle, is still unchanged; but, in order to render this or any other plan available, the number of attendant guards should be considerably increased. We observe that the Great Western Company have recently adopted the laudable plan of sending a "look-out man" by each train, whose business will he confined to the careful watching of each and every carriage in the train. With such a provision, any mishap cannot go far without discovery.—ED. P. M. J.]

DECIMAL SYSTEM OF CURRENCY.

This subject is of such immense importance to the commercial world, that I shall not deem any apology necessary for troubling you with the following remarks upon a proposition of my own.

The names for the new coins required by my system, I propose to be as follows:—*Dent*, for the coin worth 10 farthings; *sol*, for the next coin worth 100 farthings; *libra*, for the new coin worth 1000 farthings; by which name I purpose to distinguish them in this paper. Let it be understood, however, that the nomenclature of these coins is a point quite immaterial, as it will not at all interfere with the exposition, or the carrying out, of the system here laid down.

The foundation of a Decimal Coinage is then easily laid. Our copper coinage need not he disturbed; but the place of the present gold and silver coins must be taken by new ones, differing from them slightly in value. The *farthing* will he the lowest coin in the scale, and the *libra* the highest; the *dent* and *sol* will form the middle terms of the proportion, which will stand as follows:—Farthing : dent :: sol : libra; or substituting values, 1 : 10 :: 100 : 1000; so that we see the four coins are proportional, each one being in a decimal ratio to the preceding. This property alone can constitute a complete decimal system; however far the proportion is continued, and whatever be the value of the first term, every term must proceed in a decimal ratio. These four coins will be the only represented coins; intermediate coins will he useful only in circulation. I will now proceed to explain the practical operation of this new system.

It will be evident that the present silver and gold coins must be withdrawn, and their value given in new coins. To effect this, I have prepared a table, giving the equivalent value of every sum in the two systems. Every one who has considered the plan will know that the construction of this table is most easy, because they will know that every decimal sum gives the number of farthings it contains; so that, to convert any sum of pounds, shillings, and pence, into decimal money, it is only required to ascertain and write down the number of farthings that sum contains. Upon the first introduction of any new system, such a table will be required to enable shopkeepers and manufacturers to convert their prices into the new currency. I will quote a few items from it:—

S.	D.		F.
0	0¼	=	·001
0	0½	=	·002
0	0¾	=	·003
0	1	=	·004
0	2	=	·008
0	3	=	·012

In this table the simplicity and brevity of the decimal system is fully shown. The first advantage of it is its brevity—no small one indeed, when we consider the immense saving of labour and time it will effect. As an example, I will just call your attention to the fact, that *three* figures in the decimal column will express any amount of shillings, pence, and farthings, by which, in many amounts, half the labour is saved. In my table, opposite 19s. 11¾d. stands ·959, its equivalent, where three figures represent six in the old system of pounds, shillings, and pence; therefore, we see that in the mere representation of amounts, the decimal system is shorter, and consequently superior, to the existing system. It now remains for me to show its operation in arithmetical calculations.

Compound addition will be performed exactly like simple addition. The quantity of *tens* is all that requires to be carried to each succeeding column. One example is here given, placed in juxta-position with the same sum in the present system:—

£ S. D. F.		£	S.	D.
19·200	.....	20	0	0
20·000	.....	20	16	8
19·199	.....	19	19	11¾
8·429	.....	8	15	7¼
4·800	.....	5	0	0
5·000	.....	5	4	2
95·610	.....	99	11	10½
7·116	.....	7	8	3
20·212	.....	21	1	1
48·000	.....	50	0	0
247·566	=	257	17	7½

There are in the first of these sums 52 figures, and in the second 56. Besides this, we must take into account the number of coins required to represent each total sum. To pay the first amount, I should require 247 gold libras; to pay the second, 257 sovereigns. Fewer coins will he required to pay the same value in the decimal than in the present system. Thus a great saving will be made in mere money-counting.

Subtraction likewise will be like that of numbers, as the following example will show:—

£ s. d. f.		£ s. d.
247·566	.....	257 17 7½
19·199	.....	19 19 11¾
228·367	=	237 17 7¾

Those two rules, at present so tiresome and complicated, and which the schoolboys term "vexation," will be made very simple. Multiplication and division of compound sums will be just as easy as that of simple numbers; for, in the decimal system, every amount can be turned into a number, by leaving out the decimal point, and in every arithmetical operation is treated as such.

It is impossible to multiply pounds, shillings, and pence, in the short and easy manner of decimals. We are now obliged to cut up our multipliers into factors, none of which must exceed tens; so that we perform long multiplications by a series of short multiplications. Moreover, decimal sums can be multiplied by ten, or any power of tens, by moving the decimal point as many places to the right hand as there are ciphers in the multiplier. The reverse of this will perform division.

Long multiplication and long division become very easy, and may be performed in the shortest possible manner. Let any one, at all sceptical upon this point, substitute for £84·601 its equivalent in pounds, shillings, and pence, which is £88 2s. 6d., and then work various sums in the present manner; after this is done, I am certain he must candidly decide in favour of the new decimal system. He will find that, besides the great saving of figuring, there is very little mental labour required. A knowledge of the four primary rules of arithmetic will be sufficient to enable any one to perform money sums on the decimal system.

I shall now briefly glance at the manner of working some of the other arithmetical rules. Firstly—Practice will be dispensed with; for it will be found quicker and easier to use long multiplication than the "maddening" rule of practice. The reason of this is, that no reduction will be required. Every amount expresses at sight the number of farthings it contains; and as every figure to the left increases in a tenfold degree, so all multiplication by 20, 12, and 4, and division by 4, 12, and 20, is avoided. This constitutes the great beauty of the system, that the proportions between the coins is the same as between the units, tens, hundreds, and thousands, in any integral number.

The only other rules requiring notice, and those that come very much into business transactions, are interest and discount. In each, the simplest method is to multiply the principal by the rate per cent., and divide the product by 100. The operation of finding the interest or discount is the same; only, since the interest is an increase, and discount a diminution of the principal, in the first case the result must be added, and in the other subtracted. With pounds, shillings, and pence, these operations have always been troublesome; but in the decimal system they will be mere sums of multiplication. The division by 100 can be done at sight.

The simplicity of these operations is wonderful when compared with our present methods. The rules here noticed comprise all those most used in business. I hope my expositions of the working of the decimal system have clearly established and enumerated its advantages; but I earnestly request your readers to judge for themselves. I have now put them in possession of the whole plan that I have had the honour to propose.

JACIA.

NIELLO-METALLIC ENGRAVING.

The article in Part I. of your Journal, on the new art of Niello-metallic Engraving, will doubtless prove of great interest to many of the manufacturers in this town, and others where manufactures of chased articles are carried on. The *modus operandi* was thus described:—"This invention, which is applicable to the production of ornament on a vast number of objects, is as follows:—The surface to be ornamented is first covered with an etching ground, as is ordinarily done in copperplate engraving; the design is then drawn with a needle point, and etched with an acid solution. The etching ground is then removed very carefully by a proper dissolving fluid, as oil of turpentine or ether, and the object being washed perfectly clean, is submitted for a moment to the action of a weak acid solution. The next part of the operation consists in the depositing of the article in a galvano-plastic apparatus, until its surface is galvano-plastically covered; the etched lines being filled up with the metallic deposit. When this deposit is so thick as to reach as high or higher than the plain surface of the metal ground under process of ornamentation, it is removed, and the layer which has been deposited by the operation is ground or planed off to the natural level of the object, leaving the etched lines of the design full."

The preceding method is liable to a great objection, viz. the impossibility of ornamenting any but plane-surface articles in that way; which will cause a vast restriction to the extension and usefulness of the art. This can be easily remedied by adopting the following method:—After the article is covered with the etching composition, and etched with the diluted acid, immerse it at once in the galvanic trough, containing a solution of the metal required to be deposited. Remove it in a short time, and the etched lines will be found filled with the metallic deposit, while the other parts of the article, being protected by the composition, will not have sustained any alteration. Then dissolve the composition ground, and the design will appear in full beauty, with its lines clearly defined by the metal deposited therein by the galvanic process.

The troublesome operation of planing or grinding off the deposit is thus avoided; and any object, however delicate, may be ornamented by the niello-metallic process. With this modification in the original plan, goldsmiths and silversmiths will be enabled advantageously to adopt this plan of adorning their manufactures. Instead of the bare lines of the etching or chasing being seen, we shall see their designs filled up with a metal of a colour beautifully contrasted with the body of the article.

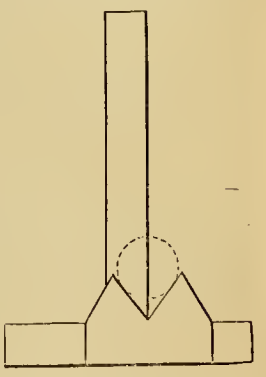
I do hope to see this scientific invention, for which we must thank the Germans, extensively applied to decorating many of our English manufactures.

C.

Birmingham, May 24, 1848.

SQUARE FOR FINDING THE CENTRE OF CIRCLES.

The accompanying sketch represents a pocket square, which I have had in use for some time. In addition to its duty as an ordinary drawing square, it answers for finding the centres of circles or rectangular bodies. For this purpose, a hardened steel plate with two projecting angles, the corners of which are equidistant from one edge of the blade, is screwed on to the stock. When any two corners of a rectangular body are applied to this plate, the central edge of the blade will pass through the centre of such body. The sketch represents the instrument as applied to a cylinder, the intersecting lines given by the central edge of the square determining the centre of the body. I have tested this instrument on a circle 12 feet diameter.



A. R.

[The engraving of our correspondent's square is one-third the size of the sketch he has supplied us. The idea is not new, as we have seen a square fitted up for a similar purpose, with two pins in the stock at equal distances from one edge of the square. The instrument to which we refer, was made, as far as we can remember, by Mr. H. Deacon, of St. Helens, Lancashire.—ED. P. M. J.]

M'NAUGHT'S IMPROVEMENTS IN STEAM ENGINES.

On referring to your Journal for this month, I find, in looking over your account of the amount of duty performed by the engines of Messrs. Johnstone, Galbraith, & Co., as recently altered on Mr. M'Naught's double-cylinder principle, that by some mistake, the 777 power-looms, with dressing and preparation, which form a portion of the work done, have been omitted. As these looms amount to about one-half of the whole work of the engines, the omission shows the duty to be very small, as compared with the amount of fuel consumed. May I beg your correction of the statement in your ensuing number.

JAS. SOMERVILLE, Manager.

Oak Bank Cotton-Works, May 22, 1848.

[On referring to our MS. we find that the error was an omission which was inadvertently overlooked in the proof-sheet. We are obliged to Mr. Somerville for pointing it out, as it seriously affects the statement of the economy of the engines. We may at the same time set right a slight discrepancy between one of the diagrams given at page 36 of our May number, and the letter-press description. In the description it is stated that the low-pressure cylinders are 34 and 38 inches diameter, respectively, and the third diagram is given as from the 34 inch, whereas it ought to be the 38 inch cylinder, from which the diagram was actually taken; it will be easily understood how this difference affects in some degree the practical result of the working of the two cylinders.—ED. P. M. J.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.—May 9, 1848.

Joshua Field, Esq., President, in the Chair.

The paper read, was "Observations on the causes that are in constant operation tending to alter the outline of the coasts of Great Britain, to affect the entrances of rivers and harbours, and to form shoals and deeps in the bed of the sea." By Mr. J. F. Harrison, M. Inst. C. E.

After noticing the gradual deterioration which the harbours of Great Britain are undergoing, the paper gave as the causes of these effects—the action of fresh water, the tidal wave, the wind waves and springs, and atmospheric changes—dwelling principally upon the tidal and wind waves.

Professor Airey's and Mr. Scott Russell's views on the positive wave of translation (first order), and the oscillating wave (second order), were examined—the peculiarity of the former being, that the motion of the whole mass of the water was in the same direction as that of the wave itself; whilst in the latter, the motion of the water was alternately opposed to, and in the direction of the wave. The tidal wave was considered as a purely oscillating wave in the open sea, changing its character as it passed into shallow water.

It was supposed that a wave of the first order was generated whenever the water, heaped up by projecting headland, passed and made its escape into the adjoining water at a lower level, and that it carried with it gravel and shingle into mid channel. The regularity of the bottom of the English Channel, and the material of which it was composed, were instanced to prove that the bottom was now in progress of formation from the aqueous action of this deposition of matter.

The effects of the tidal wave along the coasts of Poole and in the Isle of Wight were given, to show that such a wave of translation was generated, and crossed the Channel from the department De la Manche. The result of a series of experiments upon the action of waves on transportable materials, showed that certain definite forms were assumed by sand or shingle, under given circumstances. For instance, that the depth of the end of the foreshore, below the water, depended upon the size and character of the wave acting upon it.

It was urged that the end of such a foreshore was to be found at ninety or a hundred fathoms under water, stretching from Ushant to the south-west coast of Ireland; and that the tidal wave, in its progress up the Channel, drew down to the mouth the material thrown into it by the waves of translation from the headlands. The accumulative action was seen in the carriage of sand through the Straits of Dover, to be deposited on the sand-banks of the North Sea.

Referring to Mr. Palmer's paper "On Shingle Beaches," the destructive, accumulative, and progressive actions of the wind waves were considered, and the cases most favourable for the display of the effective action of each were adduced. The influence of tides by varying the height of the water, and that of an on-shore wind in facilitating the destructive action by retaining the water at a higher level, were pointed out. A flat foreshore was shown to prevent, in a great degree, the destructive action; whilst, on the other hand, deep water, whether from a strong in-shore tidal current, or from other causes, had a contrary effect—facilitating encroachments on the coast. The progressive action was shown to depend principally upon the angle at which the waves strike the beach.

The general question of the travelling of shingle, and of its ultimate destination, was considered at great length; instancing particularly the accumulation of shingle at the Chesil Bank and Dungeness. The state of the great Western Bay, between the Start Point and Portland, was examined, and arguments were offered to show that it had been formed in a great measure by the encroachment of the sea. The process of this encroachment, and the alterations in the mouths of the estuaries falling into the bay, were analysed; and extracts were given from Sir Henry de la Beche's work on the Geology of Devon and Cornwall, to prove that this process was still in operation.

The summary of the arguments in the paper was, that the observed changes in our coast and the mouths of the rivers, were the result of the combined action of the wind waves and of the tidal wave; and the attention of engineers was particularly directed to these actions in different localities, in order that, by presenting to the Institution the result of their observations, an invaluable collection of recorded facts might be assembled, which would be of great benefit to the profession, and to the scientific world.

May 16.

No paper was read, in order to afford time for the discussion of Mr. Gooch's paper "On the resistance to Railway Trains at different velocities," which was read at the meeting of April 18.

The principal speakers were Messrs. Brunel, Gooch, Bidder, Locke, Harding, and Russell, and their arguments were necessarily so complicated by calculations, as to render it difficult to convey within reasonable limits even an outline of the discussion.

It was contended, on one side, that the subject had been so treated in the paper as to make it almost a question of the comparative guages: that the experiments upon which the arguments were founded could not be received as applicable to railways in general, inasmuch as it was presumed, from the statements, that the portion of the line was stated as being in the best working condition: that the engine and the carriages were also picked as being in the best order, and that therefore the results were due to those peculiar circumstances, and not to the ordinary working state of the line: that the amount of resistance per ton was understated by Mr. Gooch on these accounts, and that the rate of resistance arrived at by the Committee of the British Association, by projecting trains of carriages down inclined planes, was nearer the truth than the expression of resistance arrived at with the locomotive and the dynamometer: that the tables were partly made up from the actual results of the experiments, and by using Mr. Harding's formula, which had been repudiated in other cases as incorrect: that the greater weight of the trains in the late experiments, as compared with those of the British Association, reduced the value of the deductions: that the atmospheric railway could alone give the resistance due to the frontage, which was not given when a locomotive was used, as it covered a portion of the carriage frontage, and the dynamometer being behind the engine, the resistance of the train of carriages alone could be arrived at; and that the valuation of the pressure of the wind upon the train at various angles was not satisfactory. Such was the general tenor of the arguments. On the other side it was urged, that Mr. Gooch had endeavoured as much as possible to avoid introducing in any degree the question of the guages, and to give the actual results of the experiments in order that every person examining them might draw their own conclusions: that the portion of the line on which Mr. Gooch's experiments were tried, was not selected for its good condition: that it was only fixed upon by Mr. Brunel himself the night previous to the experiments, and was not that part which had been originally intended to be used: that the engine and carriage were such as could be spared from the working stock, and were not picked; in fact, that they were not the best of their class: that therefore the results were not due to peculiar circumstances, but were those of the average working of the line; but that, even had the line, engine, and carriage been selected, engineers would, from the results, have been able to make allowances for other cases, and that the value of the experiment would not have been diminished: that it was believed, that in descending Wootten Basset incline by gravity without the aid of an engine, a greater velocity had been attained than the maximum recorded in the experiments of the British Association: that the tables were divided into columns, distinctly showing what resulted from experiment, and what from the use of formula: that it was impossible with engines of the ordinary weight, as now constructed, with an ordinary train, to limit the experiments to such small weights as had been formerly used: that in all cases the surface of the locomotive was allowed for in calculating the frontage resistance: that it was expressly stated in the paper, that the apparatus for the wind guage was not so satisfactory as could have been desired, and therefore its results were kept separate in the tables: that Mr. Gooch had not intended to cast any reflections upon the former experimentalists, but merely to point out the errors into which he thought they had fallen, and to induce, by his experiments, others which should fix more certainly the amount of resistance: this, it was still contended, was less than had been formerly stated, and although other experiments would be necessary to set the question completely at rest, it was unanimously agreed, that Mr. Gooch's experiments and paper were very valuable contributions, and it was hoped he would continue his observations on this most interesting subject.

INSTITUTION OF MECHANICAL ENGINEERS.

The pages of the present and previous number of our Journal afford, in Mr. Buckle's excellent paper on the Fan Blast, ample testimony of the energetic proceedings of this Institution, and the desire which it evinces for the elevation of the profession from which it takes its name. Originated by a few leading practical men, who had long canvassed the chances of success of such a society, it has been gradually strengthened by accessions of members from all parts of the kingdom, and now numbers 200 supporters. Birmingham, as the most convenient and central town, was selected as the head-quarters of the Institution, and, under the auspices of Mr. George Stephenson as President, the first organized meeting was held in the Queen's Hotel, in that town, on the 27th January, 1847. It was then decided that the meetings should be held four times a-year, but owing to the rapid increase in the number of members, the following resolution was passed on the 19th of February last: "That as there is a Vice-President in London, and another in Manchester, the council recommend the members in these districts to hold discussions regularly; the Manchester section to meet on the day month, and the London section on the day two months after the quarterly meetings: that the members of council, and the other members of the Institution in the various large and important districts, be invited to hold similar meetings; and that the Secretary be informed of the time and place of these meetings, together with such suggestions and details of the proceedings as may be deemed advantageous to the Institution."

The governing heads of the Institution are—George Stephenson, Esq. President; and three Vice-Presidents, namely, Charles Beyer, Esq., Manchester; J. M'Connell. Esq., Wolverton; and Joseph Miller, Esq., London; and thirteen council men.—Treasurer, Charles Geach, Esq.; Secretary, Archibald Kintrea, Esq.

In the official list of members which the Secretary has obligingly supplied to us, we find the foremost of the practical men of the kingdom, and several foreign residents. London and its environs furnishes 50 members; Manchester, Liverpool, Leeds, Sheffield, Derby, and York, about 70; and Scotland about a dozen—Southampton, Brighton, and Warrington send their quota, but, strange to say, Birmingham has few representatives.

To say that the labours of the members have hitherto been of a practically excellent nature, would express but feebly the opinion we have formed as to the effect they will have upon the profession. The papers and discussions of the members are generally pointed and explicit, and, what is of more consequence, they are fit for the comprehension of the operative mechanic and engineer.

The usual general meeting was held in the theatre of the Philosophical Institution, Cannon Street, Birmingham, on the 26th of April last, George Stephenson, Esq. in the chair. The President opened the transactions by referring to the paper "On boring and fitting up cylinders for Locomotive Engines," by Mr. Beyer of Manchester. Mr. Beyer was unavoidably absent, and Mr. Fothergill undertook the explanation of the construction of the machine to which the paper had immediate reference.* Mr. Fenton, of Leeds, considered that the operation was somewhat complex as regarded the chipping of the cylinder, and employing the conical plates.

* We shall shortly be able to furnish drawings of this boring machine.

Mr. M'Connell said, I can bear testimony to one part of Mr. Fothergill's statement. About three years ago, one of the engines made by Messrs. Sharp & Co. had a split cylinder, and I wrote down for another to replace it. In three days I had a cylinder sent up, which actually fitted in every particular, so that not a file had to be put upon it: showing the perfect manner in which they were got up.

The President said that the fact stated by Mr. M'Connell was very satisfactory. There could be no doubt that the idea was of importance; and the thanks of the Institution were due to Mr. Beyer for his valuable communication.

The Secretary then read the following communication, "On the Formation of the Teeth of the Drivers of Pin Wheels." By Mr. F. Bashforth:—

"The proper form of the teeth of wheels is a subject that has long engaged much of the attention of mechanicians; and for many purposes, all desirable accuracy has been attained. Still, cases occur where the ordinary spur wheels cannot be employed, and various substitutes have been tried, on different occasions, with more or less success. Professor Willis has shewn, that the proper form for the teeth of spur wheels is a compound of portions of epicycloids and hypicycloids. He confined his attention to the *proper forms of the teeth*, and to the means of *describing them*. I am not aware that self-acting machinery has been applied to give those forms to metal wheels, when mounted on their axes; and, until this is accomplished, little can be expected beyond an improvement in the ordinary application of spur wheels.

"From the facility with which almost perfect forms may be given by simple self-acting machinery to the teeth of the drivers of pin wheels, I think this old system worthy of attention. I am not aware that the method employed in the formation of the accompanying cast-iron model has ever been previously used, or recommended in any publication; but it has, at least, the merit of being simple, and capable of any degree of accuracy.

"It is well known, that if the pins be supposed to be mathematical lines, the proper forms of the teeth of the driver will be portions of the epicycloids, described by a point in the circumference of the pitch circle of the pin wheel, when caused to roll on the pitch circle of the driver. But suppose the tracer to become a cylinder, with the above-mentioned tracing *point* in its axis, the interior edge of the curve so described, will be the proper form for the tooth adapted to drive pins of the same diameter as the tracing cylinder.

"If the tracer be replaced by a cylindrical cutter, this, as it revolves on its own axis, which is caused to move in the proper epicycloid, will form with accuracy the interval between two teeth of the driver. By turning the wheel to be cut through the proper angle, the interval between the next two teeth will be formed; and so on till the whole is completed.

"I propose that the pins should be formed in two parts,—a solid cylinder surrounded by a tube of iron. These might be polished and case-hardened. The interior cylinder must be of sufficient strength to withstand the stress of the machinery, and when the tooth of the driver came in contact with the outer case of the pin, this would revolve through a small angle, and thus all abrasion of the teeth of the driver would be avoided.

"Although I am fully aware of the difficulty of giving the necessary accuracy to the teeth of metal wheels, when applied to *increase* the angular velocity of an axle, still I think this method might be applied with a reasonable prospect of success to the screws of steamers, and, if successful there, to a great variety of other purposes. Wooden teeth of any size, could, in like manner, have accurate forms given to them, but it would perhaps be found difficult to keep them in their places.

"F. BASHFORTH, M.A.,
"*Fellow of St. John's, Cambridge.*"

Mr. M'Connell observed, that he did not conceive, from this description by Mr. Bashforth, that his plan of cutting the teeth was anything different to that which was usually employed. Mr. Bashforth might imagine it was new, but he (Mr. M'Connell) believed that all pattern-makers, or all he had ever seen making wheels, were accustomed to pursue the same method as Mr. Bashforth had described. The form of teeth was decidedly what was used in the old cog and drum corn mill teeth a century ago. However, the gentleman, being an amateur, deserved credit, for he no doubt conceived the idea.—Mr. E. A. Cowper said he did not agree with Mr. M'Connell; this had the old trundle and spur wheel in it, but its teeth, if made according to the description, would be an epicycloid struck by a circle of the wheel, and the particular application of the machine was a circular cutter of the same diameter as the teeth, which should strike the teeth in the wheel; and if the teeth in the wheel were struck by a cutter exactly the diameter of the pin which was to work, it must be a true curve. It was the only proposition for a machine to cut epicycloid teeth by the operation of a machine itself.—Mr. M'Connell stated, that in his earlier days they used to strike out all the teeth of the wheel by the teeth of the pinion. The invariable rule of all the mill-wrights in that part of the country, was to take the cog and drum, and strike out the principal wheel from the pitched line of the carriage—the principal plan of forming the epicycloid.—Mr. Fothergill said there was another method, namely, that instead of striking the wheel out with the compass in the way to which reference had been made, which was the old plan, to take two blocks, one represented by the pitched line of the smaller one; let these two come in contact one with another, and have a sheet of tin upon the wheel or the pinion; put the projecting point over them, and let the ends all be brought into contact and worked from their own centres, and let them describe the form of teeth required, to show that the one shall describe the form of teeth in the pinion, and the other the form of teeth required in the wheel,—that being a true and legitimate principle, so far as he knew, of striking wheels at the present time. He did not see anything new in this proposition, but the idea might be original with Mr. Bashforth, and they ought to give that gentleman credit for it: at the same time, he candidly acknowledged that they had at the present time much improved upon the method brought before them.

Mr. Buckle thought that a great deal of merit was due to the author of the paper; and he believed the idea suggested might be found to be useful.—In these remarks the President entirely agreed.

ROYAL SCOTTISH SOCIETY OF ARTS, April 10.

[Part II. of Mr. Buchanan's paper on "The Strength of Materials." Continued from page 47.]

Some interesting experiments were then made on the tensile strength of stone from Hailes and Craigleith quarries. The Hailes stone bore on the square inch 360 lbs., the Craigleith considerably more; and a remarkable effect was observed here after the load had hung for a little: it was suggested by a member to give it a slight tap with a hammer, and on this being done, it immediately snapped asunder, showing the effect of vibration or concussion when the materials are greatly strained in aiding and completing the fracture, a circumstance which appears to throw light on what may sometimes occur by the rapid and violent actions of the trains on railways. The compressive strength of the Hailes and Craigleith stones was then shown, by experiment, to be much greater than the tensile strength; and as it required, indeed, more weight and a more powerful apparatus than could be commanded, these experiments on different stones were deferred to another evening.

The compressive strength on posts or pillars was then considered, and the remarkable effects of the length of the pillar in diminishing its strength. On this subject much light has been thrown by the experiments of Messrs. Hodgkinson and Fairbairn. Pillars or rods were tried of different lengths, from 3 inches to 5 feet, and of different diameters; rods half an inch diameter, with 3¾ inches length, bore 11 tons; but when the length was 7½ inches it only carried 5 tons, when 15 inches long, 3 tons; and at 30 inches only 13 cwt. From these experiments, a general rule may be drawn for different lengths. Taking the strength of cast-iron as formerly given at 50 tons per square inch, this will hold good in pillars until the length reaches five times the diameter, and then it begins to diminish. When the length is ten times the diameter, the strength is reduced in the proportion of 1¾ to 1; with the length at 15 times the diameter, it is reduced as 2 to 1, 20 times, as 3 to 1; 30 times, as 4 to 1; and 40 times, as 6 to 1.

Hence the great advantage in cast-iron, of using hollow pillars or tubes in place of solid metal, whereby, with the same area or section of fracture, the diameter of the pillar is increased, and with it the resistance to flexure, and an increase of strength in proportion to the length. A solid pillar, for instance, 6 inches in diameter, if extended to 7½ feet in length, would be weakened one-half, but if cast hollow, 10 inches in diameter and ¾ inch thick giving the same weight of metal per foot in length, it might then be extended to 12½ feet, and still possess the same strength as the other. In all these cases a remarkable circumstance was observed in regard to the mode of applying the strain. With the ends of the pillar turned flat, and a flat plate interposed at top and bottom, which is the case in supporting buildings, this was found to sustain nearly three times as much as when the pillar was rounded on the ends, so as to make the force pass directly through the axis, as occurs so frequently in machinery with the connecting rods of steam-engines, and in other cases. The effect of the length of pillars in weakening the strength was illustrated by a striking experiment with a spiral wire, quite flexible, yet, when set up as a pillar, and tied in the middle laterally, with slender threads, carried a weight of 56 lbs., and would have carried much more, but the moment the threads were cut, the wire gave way by flexure, and oversetting the balance, the weight immediately sunk.

The application of malleable iron had been already used in the shape of tension-rods in cast iron girders, and was applied, as we have seen, in the high level bridge at Newcastle; but the application of girders constructed of malleable iron alone is a new idea. It has been applied on railways in the case of skew bridges of wide opening and limited depth between the railway and the road; in these cases the girder consists of a rectangular hollow tube or square box, extending over the whole span, and of such depth as can be attained. These have hence received the name of tubular bridges, and have excited much attention since the grand experiment has been determined on, of trying these structures on such a magnificent scale as is now in progress of execution in the crossing of the Straits of Menai by the Britannia Bridge, and the estuary of the Conway by the Conway Bridge, and which form, without doubt, the most remarkable engineering enterprises of the present day. These spots, as is well known, had already been the scenes of vast engineering operations connected with the suspension bridges of Telford, to form the great turnpike road communication from the metropolis to Holyhead, and thence across the channel to Dublin; and when it was determined that this communication should be superseded by railway, it became a matter of most serious consideration how these two openings were to be spanned, keeping in view the new conditions of stability required for railway traffic; and the subject having been remitted to Mr. Stephenson, the engineer of the line of railway, namely, the Chester and Holyhead, he at once rejected the principle of the suspension bridge as inapplicable, owing to the undulations to which it was liable, and which had been proved by practice in a similar bridge for a railway across the Tees to be both inconvenient and dangerous. How far the principle might have been modified by the introduction of proper ties and braces may be a question; but in a case of such vast magnitude and importance, there might still have been risk, and, on the maturest consideration, Mr. Stephenson determined to recommend the simple and bold design of a hollow rectangular tube of malleable iron, consisting of thin plates rivetted together, such as he had already tried, with success, on a smaller scale upon railway bridges, and which he conceived was the best form for securing not only strength, but sufficient stability and stiffness, to prevent any undue oscillations or vibrations. To carry out this plan, the assistance of the first authorities, scientific and practical, on the strength of materials was called in, and to Messrs. Hodgkinson and Fairbairn the duty was remitted of trying the effect with experimental tubes on a small scale, and finally on a model one-sixth of the dimensions of the bridge, being 75 feet long.

Messrs. Wilson's Locomotive Engine.—We have to correct an error in our notice of this engine in our April No. In it we stated that it was upon the Cambrian principle. This is not the case. The engine has four seven feet driving wheels with their centres 16 feet apart, and between them is a vibrating shaft, conveying the motion from two inside cylinders to two connecting rods working the fore and back wheels. Messrs. Thwaites & Co., of Bradford, are constructing an engine with the same system of connecting rods, but worked by a Cambrian cylinder, and to this fact the error is owing. We shall have more to say regarding both engines shortly.

ENGLISH PATENTS.

Sealed from 27th April, 1848, to 18th May, 1848.

William Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in machinery for burring, ginning, and carding wool and cotton, or similar fibrous materials requiring those processes."—(Communication.)—April 27th.

Edward Walmsley, Heaton Norris, Lancashire, cotton spinner,—"Certain improved apparatus for preventing the explosion of steam boilers."—27th.

William Henry Barlow, Derby, civil engineer, and Thomas Forster, Streatham Common, Surrey, gentleman,—"Improvements in electric telegraphs, and in apparatus connected therewith."—27th.

Thomas Edmondson, Manchester, machinist,—"Improvements in marking and numbering railway and other tickets or surfaces, and in arranging and distributing tickets."—27th.

Daniel Rice Pratt, Worcester, Massachusetts, America,—"Machinery for connecting railway carriages."—27th.

James K. Howe, New York, America,—"Improvements in building ships and other vessels."—27th.

Roger George Salter, Birkenhead, Chester, surveyor,—"Certain improvements in carts for the distribution of liquid substances, and in the construction of drains, sewers, and cesspools, and in the cleansing of the same."—27th.

Charles Fielding Palmer, Birmingham,—"A new or improved chalybeate water."—27th.

Alexander Parkes, Birmingham, experimental chemist,—"Improvements in the manufacture of metals, and in coating metals."—27th.

William John Normanville, Park Village, Middlesex, gentleman,—"Certain improvements in railway or other carriages, partly consisting of new modes of constructing the axle-boxes and journals of wheels, also an improved method of lubricating the said journals or other portions of machinery, by the introduction of aqueous, alkaline, oleaginous, or saponaceous solutions."—May 2d.

Isaac Hartes, Rosedale Abbey, York, farmer,—"Certain improvements in machines or machinery for rolling, sowing, and manuring lands."—2d.

Isaiah Davies, Birmingham, engineer,—"Certain improvements in steam engines and locomotive carriages, parts of which are also applicable to other motive machinery."—2d.

Alexander Southwood Stocker, York-place, City-road,—"Certain improvements in time-teachers and boxes, show-cards, or holders for matches, pens pins, needles, and other articles, and in the mode or modes of manufacturing the same."—4th.

Felicité Raison Sellique, 6 Boulevart, Beaumarchais, Paris, widow,—"Certain improvements in propelling, and the machinery employed therein."—(Communication from her late husband.)—4th.

Henry William Schwartz, Great St. Helen's, London, merchant,—"Improvements in steam-engines."—(Communication.)—4th.

Lewis Dunbar Brodie Gordon, Abingdon-street, Westminster, civil engineer,—"An improvement or improvements in railways."—9th.

William M'Lardy, Salford, manager, and Joseph Lewis, of the same place, machine-maker,—"Certain improvements in machinery or apparatus applicable to the preparation and spinning of cotton, wool, silk, flax, and other fibrous substances."—9th.

Richard Laming, Clichy la Garonne, France,—"An improvement or improvements in the manufacture of oxalic acid."—9th.

Edward Haigh, Wakefield, plumber and manager of the Wakefield Waterworks Company,—"An invention for measuring water or any other fluid."—9th.

Charles Hancock, Brompton, Middlesex,—"Certain improved preparations and compounds of gutta percha, and certain improvements in the manufacture of articles and fabrics composed of gutta percha, alone and in combination with other substances."—11th.

Thomas Wressell, Tooting, Surrey, watch-maker, and Richard Clark, Strand, Westminster, lamp manufacturer,—"Improvements in chronometers, clocks, watches, or other time-keepers."—11th.

Vincent Price, Wardour-street, Soho, Middlesex, machinist,—"Certain new or improved mechanical arrangements for obtaining and applying motive power."—11th.

George Armstrong, Newcastle-upon-Tyne, engineer,—"An improved water-pressure engine."—11th.

Mark Smith, Heywood, Lancashire, power-loom maker,—"Certain improvements in looms for weaving."—11th.

William Taylor, Birmingham, mechanist,—"An improved mode of turning up or bending flat plates of malleable metals, or mixture of metals, by aid of machinery, into the form of tubes."—18th.

SCOTCH PATENTS.

Sealed from 20th April, 1848, to 17th May, 1848.

Bartholomew Beniowski, Bow-street, Covent Garden, Middlesex, major in the late Polish army,—"Certain improvements in the apparatus for and process of printing."—April 24.

Richard Turner, Bath-place, New-road, Marylebone, and Hammersmith Works, Dublin, wrought iron manufacturer,—"Certain improvements in wrought iron girders in the construction of roofs for railway stations, and roofs and floors of other buildings."—May 1st.

Thomas Hancock, Stoke Newington, Middlesex, gentleman, and Reubeu Phillips, Islington, Middlesex, chemist,—"Improvements in the treating or manufacture of gutta percha, or any of the varieties of caoutchouc."—2d.

John Henderson Porter, Blackheath, Kent, engineer,—"Improvements in iron girders, beams, trusses, and supports for buildings, bridges, and other structures, and in rendering the floors of buildings fire proof by the use of iron."—3d.

Joseph Paul, Thorp, Abbots Hall, Norfolk, farmer,—"Improvements in cutting or forming drains in land, and for raising subsoils to the surface of the land."—3d.

Henry William Schwartz, Great St. Helen's, London, merchant,—"Improvements in steam engines."—(Communication.)—3d.

William John Normanville, Park Village, Middlesex, gentleman,—"Certain improvements in railway or other carriages, partly consisting of new modes of constructing the axle-boxes and journals of wheels, also an improved method of lubricating the said journals, or other portions of machinery, by the introduction of aqueous, alkaline, oleaginous, or saponaceous solutions."—3d.

Richard Madigan, Haverstock Hill, Middlesex, civil engineer,—"Certain improvements in the manufacture of railway turn tables."—4th.

Edward Walmsley, Heaton Norris, Lancashire, cotton spinner,—"Improved apparatus for preventing the explosion of steam boilers."—5th.

Peter Claussen, Leicester-square, Middlesex, gentleman,—"Certain improvements in weaving machinery, and in the preparation of the materials employed in weaving."—(Partly his own and partly a communication.)—8th.

John Aitken, Russell-street, Bermondsey, Surrey, leather dresser,—"Improvements in steam engines, atmospheric engines, in distillin ; and in pumping water."—8th.

John Bethell, Parliament-street, Westminster, gentleman,—"Improvements in preserving vegetable and animal matters."—8th.

Edward Wand, Bradford, York, spinner,—"Certain improvements in the construction of machinery for preparing and spinning alpaca, mohair, wool, flax, and other fibrous materials."—10th.

Joseph K. Howe, New York, U. S., manufacturer,—"Improvements in building ships and other vessels."—12th May.

Thomas Forsyth, New-road, Middlesex, engineer,—"Improvements in the manufacture of railway wheels."—12th.

George Heaton, Birmingham, engineer,—"Improvements in locomotive engines."—12th.

Richard Baird, Dundee, Forfarshire, engineer,—"A new or an improved method of communication between the guards, engine drivers, and other servants in charge of trains of carriages and waggons on railways, and also between the passengers and engine drivers and other servants in charge of such trains."—16th.

IRISH PATENTS.

Sealed from 20th April, 1848, to 20th May, 1848.

James Pedder, New Union-street, Middlesex, engineer,—"Certain improvements in steam engines, and in propelling."—April 26.

George Ferguson Wilson, Belmont, Vauxhall, Surrey, gentleman,—"Improvements in treating and manufacturing certain fatty or oily matters, and in the manufacture of candles and night lights."—May 11th.

John Martin, Killyleagh Mills, Down, Ireland,—"Improvements in preparing and dressing flax, tow, and other fibrous substances, and in doubling, drawing, and twisting flax, tow, and other fibrous substances, and in the machinery to be used for such purposes."—17th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from April 20th, 1848, to May 17th, 1848.

April 20th, No. 1420. George Schofield, Sheffield,—"Thumb-bit and joint for joiners' brace-pad to act on the upright by pressure."
— 1421. Howard Ashton Holden, Birmingham,—"Carriage lamp."
— 1422. A. and M. Burton, John's-place, Blackfriars,—"Effluvia-valve and gulley-grate for small sewers and drains."
22d, 1423. Edwin Greenslade Bradford, Teignmouth,—"Brooch catch."
— 1424. Robert Best, Birmingham,—"Rack pulley."
— 1425. Samuel Gilbert, junior, Stamford,—"Somapantic bath."
25th, 1426. Frederick Skinner, Sheffield,—"The Archimedean reel (fishing)."
— 1427. William Riddle, Blackfriars-road,—"Folio clip."
— 1428. Walley and Hardwick, Oxford-street,—"A lady's mantle."
— 1429. George Palliser and Co., Finsbury-place North,—"Improved buckle."
26th, 1430. Joseph Hines and John Nicholson, Bishop Auckland,—"Spring drill."
— 1431. Simcox, Pemberton, and Sons, Birmingham,—"Rack pulley."
— 1432. James Medwin, Regent-street,—"Resilient boot."
29th, 1433. Osmond Oliver, John-street, Tottenham-court-road,—"Nonpareil universal ventilator."
— 1434. Joseph W. Schlesinger, Clement's-lane, London,—"Expanding portfolio."
May 1st, 1435. William Riddle, Blackfriars-road,—"Label damper."
— 1436. William Riddle, Blackfriars-road,—"Foot bath."
— 1437. William Scott, Exeter,—"Trap for drains."
2d, 1438. Robertson and Jobson, Sheffield,—"Register stove."
— 1439. Welch, Margetson, and Co., Cheapside,—"Shirt vest."
— 1440. Samuel Roberts and Joseph Slater, Sheffield,—"Asparagus tongs."
4th, 1441. Henry Curtis, Moor-end, Hambrook, near Bristol,—"Ribbed deep draining tool, for clay and tenacious soils."
8th, 1442. Thomas Parker, Peterborough,—"Portable box oven."
— 1443. John Crichton, 44 London-street, Glasgow, machinist,—"Antomatic water-feeder, guage, and alarum for steam boilers."
— 1444. George Simpson, 3 West Nile-street, Glasgow, mining engineer,—"Duplex straight-edge protractor."
— 1445. Barrett, Exall, and Andrews, Katesgrove Iron-works, Reading, Berks,—"Haymaking machine."
9th, 1446. John Pinchback, Atherstone,—"Bee-hive."
10th, 1447. Thomas Stokes, and Charles J. Atkinson, Birmingbam,—"The globular coal-vase.
15th, 1448. Alfred Henry Still, Gas Light and Coke Company's Works, Shoreditch—"Gas purifier."
16th, 1449. Robert Linton and John Whitfield, Liverpool,—"Improvements in the art of cutting and putting together all manuer of sails which are set or used on sailing vessels and steamers (jibs excepted).
17th, 1450. John Davey Hailes, Linton, Cambridgeshire,—"Universal orrery globe"
— 1451. Robert Henry William Bartlett, Epsom,—"Eye for stair-rods."
— 1452. Henry Bolt, Birmingham,—"Portable letter steel-yard.

TO READERS AND CORRESPONDENTS.

M. N. O., Peterhead—Wishes to have "the most approved plan of a portable crane suitable for quays, and capable of lifting three or four tons."

H. W. Harper, Manchester.—1st. Nasmyth's pile-driving machine has been already engraved elsewhere; we shall notice any improvements in it. 2d. We shall endeavour to supply this in due season. 3d. This machinery is not worth it.

Eccentric Gab.—A correct knowledge of our faults places us half way on the road to amendment, and we have to thank our correspondent for thus assisting us on such a material point. We wait the arrival of his own condemnation of the invention to which he refers. Page 3 will instruct him how to calculate the power of a blow, "ten tons falling ten feet." The particular cut is not perfection, but it is clear enough for any one who wishes to understand it. Is not his "gab" rather too "eccentric"?

R. I., Kirkintilloch.—The engraving is perfectly clear. The actuating screw is fitted in the slot in the usual manner, and gears with the rack-teeth cut on the edge of the lever. If the rack is curvilinear on its edge, the screw may be laid in the slot of the travelling jaw, when the whole may be passed over the handle, so that the screw will gear with its rack, and cannot leave its place.

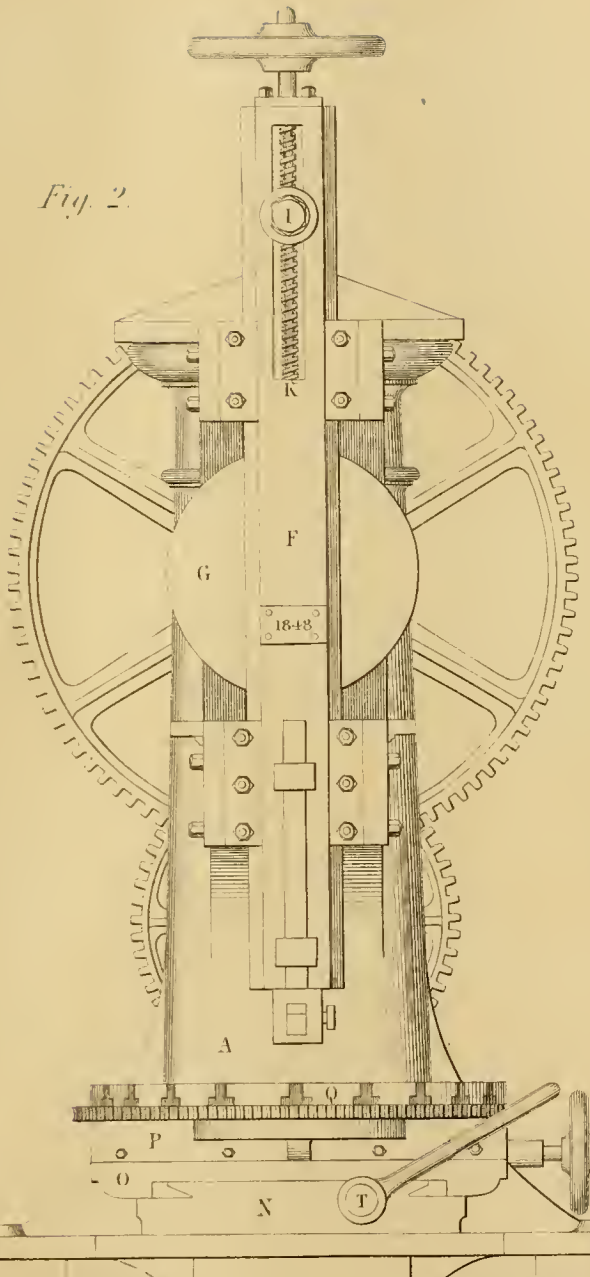
W. Wendle, Spofforth.—He can have any No. of the "Practical Mechanic's Journal" sent him per post for 6d. additional, paid in stamps. It will arrive much earlier by this conveyance.

J. L., Woolwich.—We shall be glad to hear from him on his experiments with metallic compounds.

J. Braidwood, Johnstone.—The furnace bars of the Cowlairs engines are set at a vertical, not a horizontal, angle. We do not by any means see the philosophy of placing them as he states. Can he give us the rationale of it? It is no uncommon case for two parties to hit on the same thing, and it would appear that the apparatus he put up in Johnstone was not known or put in operation beyond the immediate district, it is therefore no argument against the originality of Mr. Robinson's invention. We are of course quite willing to give him equal credit for the discovery. For his good opinion of our labours, we feel highly obliged.

W. Cross, Loughborough.—The parallel ruler he has sketched for us is too complicated. We have no doubt of its answering the intended end; but the increase of working parts will more than counterbalance its superior action, except, perhaps, on a large scale.

Fig. 2.



G Aikman Sc

20 Feet

Fig 1

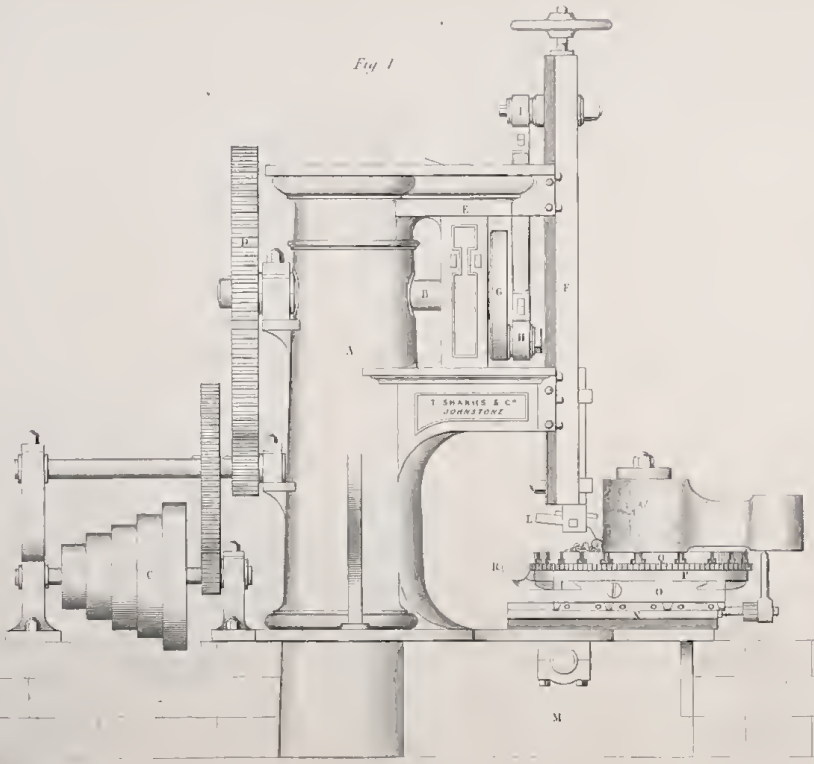
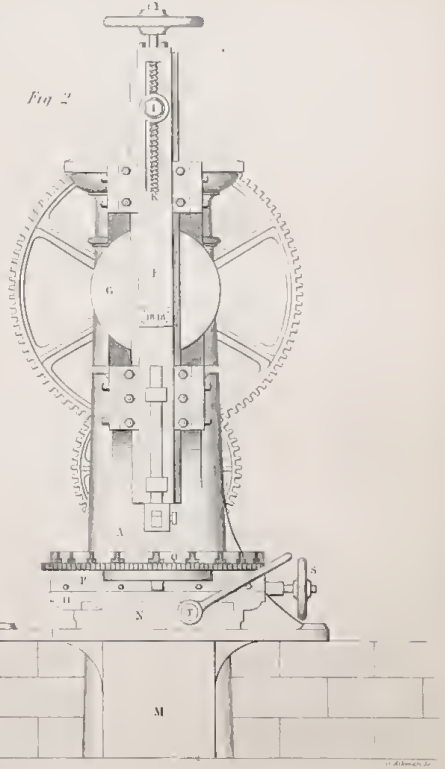


Fig 2



WORKSHOP ECONOMICS.—CONSTRUCTIVE MACHINERY.—SHANKS' SLOTTING AND SHAPING MACHINE.

Illustrated by Plate 7.

The value of machinery and manufactures has been well defined to consist in "the addition which they make to human power, the economy of time, and the conversion of substances apparently the most common and worthless into valuable products." By the assistance of machinery, we can avail ourselves of accumulations of power—we can exert forces too large for human power, and can accomplish operations too delicate for human touch. An investigation into the results of modern machinery, as evidenced in the excellence of the manufactures of the age, shows that our superiority owes less to brilliant and startling discoveries, than to gradual accumulations of experience, and successive extensions of the reproducing system of tools. With every addition to the common stock of knowledge, came an abridgment of human labour; every tool diminished the expenditure of muscular force, and, in return, demanded only a slight amount of mental exertion.

The man who invented compasses, wherewith to trace that most simple and symmetrical of all mathematical figures, the circle, exhibited a happy exertion of genius, for he not only thus economized his time, but attained unsurpassable accuracy of delineation. The schoolboy or the untutored savage, in converting crude materials into a circular or cylindrical form, retains his work stationary, and reduces it with a moving-cutting, or abrading instrument. Like the circle produced without the aid of compasses, the figure is inaccurate, and involves the employment of a large amount of time and labour. By a converse application of the principle of the compasses, the operation was at once rendered accurate and simple. Two points fixed in the same plane served as an axis for the material to be cut, and a stationary tool held against it produced the accurate figure.

To this principle of the lathe, as a convenient means of conversion of materials, we are indebted to a greater extent than to any other mechanical contrivance. In the familiar example of the screw, the extreme value of its services is self-evident. Previous to the general application of the lathe, it would appear that screw-threads were originated by wrapping a wedge-shaped piece of paper round a cylinder; the oblique line given by the sloping edge of the paper being cut through with a sharp instrument, gave a rude outline of the path of the thread, which was afterwards enlarged by hand. The lathe principle afforded the primary means of simplifying this arrangement, for in Plumier's "*Art du Tourner*," the author represents the blank cylinder mounted between centres for the purpose of assisting the operation of cutting out the thread. The first tolerably good thread then assisted in copying itself; and, the process being continued, led to the attainment of the refinements of screw-cutting with which our workshops now abound.

The same principle, applied to the production of flat surfaces, resulted in the invention of the planing machine; and the economic accession of this class of tools, by lessening the employment of files, has revolutionized the workshop routine, and elevated the standard of excellence of its productions. In like manner, the operations of boring, punching, drilling, and slotting, have been gradually simplified by the use of large and expensive tools; and it is a remarkable fact in the history of workshop economics, that the automatic tools now in operation are often many times more costly than the complete machines upon which they are employed.

Plate 7 illustrates one of the latest examples of the largest class of constructive machines—the slotting machine, as made by Mr. Shanks of Johnstone, for Messrs. Fulton and Neilson of Lancefield Forge. This species of tool is of very recent introduction, and may be considered simply as a modification of the planing machine, with a moveable tool. It is second to none in importance to the engineer for the reduction of large masses of metal, for its appearance has virtually thrown the file and chipping-tool out of employment, especially in large works.

Fig. 1 is a complete side elevation of the tool in working action, showing the arrangement and attachment of the base; fig. 2 is a corresponding front view. The main column, A, 19 feet in height, is cast with diametrical openings near its upper end, for the reception of the disc shaft, B, for giving motion to the slotting bar. The five-speed cone pulley, through which the machine is driven, is seen at C, on the base behind the column; it is connected by intermediate spur-gearing with the large spur wheel, D, on the disc shaft. This shaft is carried at one extremity by a bearing, supported on a bracket cast on the back of the main column, its contrary end being similarly retained by a bearing in the central portion of the brackets, E E, of the tool-slide, cast on the front of the column. The projecting palms of the brackets are faced and formed with V cheeks, between which the slotting-bar, F, slides vertically, the V cheeks being adjustable by set screws on each side, so as to retain the sliding bar in its correct central position. The disc, or crank wheel, for giving motion to the slotting bar, is represented at G; it is keyed on the front extremity of the disc shaft, H, and has a diametrical dove-tailed groove formed across its face for the reception of the dove-tailed head of a stud bolt, by which the disc is attached to the end of the connecting rod, H. By a simple arrangement, a single nut on the extremity of the stud bolt answers as well for the setting of the stud in the groove of the disc, as for the attachment thereto of the connecting rod. The stud is furnished with a ferrule or deep shoulder, of slightly greater length than the width of the connecting-rod eye, which fits loosely upon it; the adjusting nut then jams the dove-tailed head of the stud, without interfering with the free action of the connecting-rod joint. In this manner, the length of stroke of the slotting bar may be regulated from 33 inches, the greatest length of cut, to the slightest perceptible motion.

The upper end of the connecting rod is attached to the slotting bar by an adjustable stud, I. The front view of the machine, fig. 2, shows a central slot in the bar, F, of a considerable length; between the two sides of this slot, the rectangular portion of the stud, I, is accurately fitted. This portion of the stud is formed with shoulders bearing against the inside of the slotting bar, and is adjustable on the face of the latter by a large pinching nut. The central part of the stud in the interior of the bar is formed into a nut, through which the vertical square-threaded screw, K, is passed. This screw, which is fitted with a hand-wheel at the top of the bar, passes downwards to the bottom of the slot in the latter, where it rests upon a footstep; and, having a collar at its upper end, has no end-long motion independent of the bar, but, when worked by means of its hand-wheel, it will be seen that it will adjust the stud, I, in any required position in the vertical slot. The stud thus acts as a centre of suspension for the bar, F, and by turning the hand-wheel of the screw in either direction, the bar may be elevated or depressed to suit the tool for the different kinds of work upon which it may be employed. The cutting tool, L, is secured by wedges into a species of holder, held down to the face of the bar by two stout glands, the screwed ends of which pass through the bar, and are secured by nuts behind.

The table for carrying the work is supported upon a rectangular projection, M, cast in one piece with the main column. Upon this projection, which is level with the floor, the lower horizontal slide-plate, N, is attached. Upon this slide-plate the lower rectilineal slide, O, is fitted by dove-tails in the usual manner. The latter again is adjusted upon the upper sliding table, P, the motion of which is at right angles to that of O, and the whole is surmounted by the circular-motion table, Q. The whole of these slides are rendered automatic by a connection with an eccentric on the disc shaft, B; but our plate represents the apparatus as fitted with hand-gear only. The upper circular table is provided with a worm-wheel on its circumference, into which the worm, R, is geared; a hand-wheel, on the spindle of the latter, furnishes a simple means of adjustment of the

table in a eireular direetion. The two rectilineal slides are worked hy traverse serews, s t. By these several motions, any point on the upper table may be brought direetly under the eutting edge of the tool; and by eonneeting the different traversing apparatus of the slides with the aetuating eeeentrie on the dise shaft, the most eomplex forms may he eut out without any additional assistanee.

Our drawing represents the maehine as cutting out the round end of a wrought-iron erank for a marine engine. The erank is held down on the table by a T headed bolt passed through the erank-eye, upon whieh a thiek metal washer is laid for the seeuring nut to bear against. A series of radial T grooves in the faee of the table, presen t every faeility for adjusting the attaehing bolt.

The heaviest wrought iron eranks for marine purposes are eompletely finished by it in the most aeeurate manner, the eireular motion of the upper table answering for the rounded ends, and the reetilineal motions of the two lower slides for the straight line portion of the arm. We append a few partieulars of Messrs. Fulton and Neilson's maehine, whieh will serve as illustrations of its immense size:—

Column, 19 feet high; 4 feet 6 inehes diameter; average thiekness, 3¾ inehes; weight,.....	28 tons.
Weight of dise-shaft and dise,.....	2½ „
„ slotting har,.....	3¼ „
„ slide-rest and eireular table,.....	14 „
„ wheels, shafts, eones, pedestals, &e..	6 „
„ slide-serews, eonneeting link, bolts, &e.....	2 „
„ top-gear, shafts, and eonnections,.....	3¼ „
Total,.....	59 tons.

REPORT OF EXPERIMENTAL INVESTIGATIONS ON COALS, FOR THE STEAM NAVY.

By Sir H. De La Beche and Dr. Lyon Playfair.

The best Cornish engines are stated to raise 1,000,000 lbs. to the height of one foot, by every pound of coal eonsumed; so that only about $\frac{1}{8}$ of the *actual* foree generated beeomes available, or only $\frac{1}{11}$ or $\frac{1}{12}$ of the foree theoretieally possible, is applied in praetiee. The various experiments made on boilers, with regard to the evaporative power of eoal, have not given very uniform results. Smeaton, in 1772, with one pound of Newcastle coals, evaporated 7·88 lbs. of water from 212°; Watt, in 1788, came to the eonclusion that 8·62 lbs. of water might be evaporated by the same quantity of eoal; and later (in 1840), Wieksteed found that 1 lb. of Merthyr eoal could be made to evaporate 9·493 lbs. of water from 80°, whieh is equal to 10·746 lbs. from 212°. In some experiments made on the boiler of the Loam's engine, at the United Mines, in Cornwall, each pound of coal was found, hy a trial of six months, to evaporate 10·29 lbs. of water from 212°, this being the reduetion of the result given, viz., that 234,210 cubie feet of water at 102° were evaporated by 700 tons of eoal. Statements have indeed been made, that 14 lbs. of water have been evaporated by 1 lb. of coal burned in Cornish boilers; but as this is the utmost quantity theoretieally possible, it is difficult to eoneeive that it has been realized in praetiee, even in the best construeted steam-engines.

To aseertain how far our boiler was inferior to Cornish boilers, as prineipally from its small size and less effieient eoating it was likely to prove, we requested Mr. Phillips to make some experiments on one of the best engines in Cornwall, the results of whieh are given in the Appendix, Seetion II. It was found by these experiments, that 11·42 lbs. of water were evaporated hy every pound of Welsh coal, eorresponding in composition to that of Mynydd Newydd; or, in other words, that improved Cornish boilers on a large seale may be assumed to have a superiority of nearly 20 per ent. over that used in these experiments. As the results stated in this Report are only relative, the comparison is not affeeted hy this differenee.

We have anxiously looked to the applieation of these experiments to the different varieties of patent fuel, but we have not been able to earry out our observations in this direetion to the extent we could have desired, from our inability to proeure patent fuels in suffieient number, although our applications to the patentees have been numerous. Three varieties have been already examined, viz., those manufaetured under the patents of Messrs. Wylam, Warlieh, and Bell, and the results are given in the Tables. The varieties of patent fuel are generally made up in the shape of brieks, and are therefore well adapted for stowage; so that, though the speeifie gravity of patent fuels is lower than that of ordinary eoals, from their shape and meehanieal strueture, there are very few eoals whieh eould be stowed in a smaller space per ton. While we look to the different varieties of patent fuel as of the highest importanee, and, from their faeility of stowage, as being peculiarly adapted for naval purposes, and perhaps even destined to supersede ordinary eoal, at the same time the greater part do not appear to be manufaetured with a proper regard to the eonditions required for war-steamers. It is usual to mix bituminous or tarry matter with bituminous eoal, and from this compound to make the fuel. An assimilation to the best steam coals would indieate, however, the very reverse proeess, and point to the mixture of a more anthraeitie eoal with the bituminous eement. As the greater part is at present made, it is almost impossible to prevent the emission of dense opaque smoke—a eireumstanee extremely ineonvenient to ships of war, as betraying their position at a distanee at times when it is desirable to eoneeal it. Besides this and other ineonvenienees, the very bituminous varieties are not well suited to hot elimates, and are as liable to spontaneous eombustion as eertain kinds of eoal. To avoid these inconvenienees, some kinds of patent fuels have been subjected to a sort of eoking, and thus, in a great measure, obtain the desired eonditions. There is little doubt, however, that notwithstanding the large number of patents in operation for the manufaeture of fuel, its value for the purposes of war-steamers might be mueh enhanced by its preparation being speeially directed to this objeet. It will be seen, by referenee to Table II., that the three patent fuels examined, rank among the highest results obtained. Should it be desirable to eontinue this inquiry, we eoneeive that it would be advantageous to pay espeeial atteution to this subjeet, by experimenting upon proper mixtures of different eoals. Even anthraeite may be introduced into sueh mixtures with advantage.

It is of mueh importanee, in an eeonomieal inquiry on eoals, to obtain exact information as to the effects likely to be produeed upon them by stowage, and continued exposure to high temperature, not only as regards their deterioration, hut also as to the emissiou of dangerous gases by their progressive ehanges.

The retention of eoal in iron bunkers, if these are likely to be influenced by moisture, and especially when by any aeeident wetted with sea-water, will cause a speedy corrosion of the iron, with a rapidity proportionate to its more or less efficient protection from corroding influenees. This corrosion seems due to the aetion of earbon or coal forming with the iron a voltaic couple, and thus promoting oxidation. The aetion is similar to that of the tubereular eoneretions whieh appear on the inside of iron water-pipes, when a piece of carbon, not ehemieally combined with the metal, and in contact with saline waters, produees a speedy corrosion. Where the "make" of iron shows it to be liable to be thus corroded, a meehanical protection is generally found suffieient. This is sometimes given by Roman eement, by a lining of wood, or by a drying oil driven into the pores of the iron under great pressure.

Recent researches on the gases evolved from coal, prove that earbonie aeid and nitrogen are eonstantly mixed with the inflammable portion, showing that the coal must still be uniting with the oxygen of the atmosphere, and entering into further deeay.

Deeay is merely a eombustion proceeding without flame, and is always attended with the production of heat. The gas evolved during the progress of deeay, in free air, consists prineipally of carbonie aeid—a gas very injurious to animal life. It is well known that this change in coal proeeeds more rapidly at an elevated temperature, and therefore is liable to take plaee in hot climates. Dryness is unfavourable to the change, while moisture causes it to proeeed with rapidity. When sulphur or iron pyrites (a eompound of sulphur and iron) is present in eonsiderable quantity in a coal still changing under the action of the atmosphere, a second powerful heating cause is introduced, and, both acting together, may produce what is termed *spontaneous combustion*. The latter cause is in itself suffieient, if there be an unusual proportion of sulphur or iron pyrites present.

The best method of prevention, in all sueh cases, is to ensure perfect dryness in the coals when they are stowed away, and to select a variety of fuel not liable to the progressive decomposition to whieh allusion has been made. This is, however, a subjeet of so mueh importanee to the steam navy, that it continues to receive our careful attention; and beyond these general recommendations, it would he premature to offer any decided course for adoption, from the present limited series of observations.

Several varieties of coal were transmitted from Formosa and from Borneo, for analysis, the results of whieh are contained in the accompanying Table. The quantity of each kind was so small that no experiments

could be made on their evaporative value. We extract from the preceding Table the following results :—

Name.	Carbon.	Hydrogen.	Nitrogen.	Sulphur.	Oxygen.	Ashes.	Specific gravity.
Formosa Island	78·26	5·70	0·64	0·49	10·95	3·96	1·24
Borneo, Labuan kind ..	64·52	4·74	0·80	1·45	20·75	7·74	1·28
„ 3 feet seam....	54·31	5·03	0·98	1·14	24·22	14·32	1·37
„ 11 feet seam.....	70·33	5·41	0·67	1·17	19·19	3·23	1·21

It may be desirable to sum up, in a few words, some of the principal points alluded to in the previous parts of this Report. It has been shown that the true practical value of coals for steam purposes depends upon a combination of qualities, which could only be elicited by carefully and properly continued experiments. Their qualities, so far as regards steamships of war, may be stated as follows:—

1. The fuel should burn so that steam may be raised in a short period, if this be desired; in other words, it should be able to produce a quick action.
2. It should possess high evaporative power, that is, be capable of converting much water into steam, with a small consumption of coal.
3. It should not be bituminous, lest so much smoke be generated as to betray the position of ships of war, when it is desirable that this should be concealed.
4. It should possess considerable cohesion of its particles, so that it may not be broken into too small fragments by the constant attrition which it may experience in the vessel.
5. It should combine a considerable density with such mechanical structure that it may easily be stowed away in small space; a condition which, in coals of equal evaporative values, often involves a difference of more than 20 per cent.
6. It should be free from any considerable quantity of sulphur, and should not progressively decay; both of which circumstances render it liable to spontaneous combustion.

It never happens that all these conditions are united in one coal. To take an instance: Anthracite has very high evaporative power, but, not being easily ignited, is not suited for quick action;" it has great cohesion in its particles, and is not easily broken up by attrition, but it is not a caking coal, and therefore would not cohere in the furnace when the ship rolled in a gale of wind; it emits no smoke, but, from the intensity of its combustion, causes the iron of the bars and boilers to oxidate or waste away rapidly. Thus, then, with some pre-eminent advantages, it has disadvantages which, under ordinary circumstances, preclude its use. The conditions above alluded to may, however, often be united in fuels artificially prepared from coals possessing these various qualities, somewhat in the manner of what are usually termed "patent fuels;" and we have recommended that experiments should be made with this object, especially directed to the wants of the steam navy. Whilst we look with this view to artificial fuel as being of special importance, it was quite necessary to obtain a knowledge of coals in different districts; and, for this purpose, Wales was first selected for examination, as producing coals of all kinds, varying from bituminous to anthracitic.

While the experiments devised to obtain information on the various points alluded to have been conducted with all proper precaution, in order that constant *comparative* results might be procured, they have not been overburdened with scientific corrections, which might have been necessary to obtain absolute truth, but would have introduced an affectation of accuracy where practical results only were required; to the latter, therefore, this Report has been principally confined. The Report has been so divided as to bring the results together without complicating them with the details of the properties peculiar to each coal, information on which is of the highest value. Hence, in Table II., the practical results of the experiments are brought together, while the equally practical information regarding each coal, its local position, the port from whence it is shipped, its price, its peculiar characteristics in burning, the greater or less quantity of smoke and of ashes which it produces, the description of the coal, its geological position, and other similar points of importance in practice, are detailed for each coal in Section II. of the Appendix.

The composition and specific gravities of the coals, and the quantity of coke which they produce, are given in Table III., not only as a means for their future identification, but also as a standard of quality, with relation to which particular kinds may be purchased. The amount of sulphur, as given in this Table, is of considerable importance in determining the value of the coal for naval purposes, as a means of avoiding the risk of spontaneous combustion.

The heating values of the coal are given in Table IV., as a simpler and more ready method of identification, enabling the purchaser to insure the sample of the coal of a certain heating value.

Table V. shows how the inquiry might easily be extended to other branches of national industry, especially to gas manufactures, but is only adduced as an example of its applicability for such purposes.

Table VI. is principally for the purpose of showing that the actual duty obtained by the combustion of coal, in the best applied practice, is only a small part of that which the fuel is capable of producing, and is brought forward as an inducement to improvement in the construction of the furnaces and boilers employed for the production of steam. Attention is also drawn in this Table to the great loss which agriculture suffers by the waste of ammonia, always produced in the coking of coal, and which might to a great extent be economized by very simple adjustments to the ovens used in coking. The economy and consequent reduction of price in the ammoniacal salts, by preventing this great loss in a material so well fitted to aid increased production in land, would be a great boon to agriculture. Suggestions have also been thrown out as to the more economical application of fuel for domestic and for manufacturing purposes.

In concluding this First Report, we cannot refrain from drawing attention to the kind manner in which we have been assisted by various public and private institutions and companies, without whose aid the expenses of the inquiry would have been materially increased.

The College for Civil Engineers, at Putney, afforded us, gratuitously, ground upon which to erect the boilers, and a house and yard for the stowage of the coals. The laboratory and workshops of the College were also placed at the disposal of the investigation, and have constantly been used. The Principal of the College, the Rev. Mr. Cowie, on all occasions, afforded his valuable aid in the prosecution of the experiments.

The owners of the collieries, from which the coals were obtained, furnished them free of expense; and the Great Western Railway Company, with an enlightened liberality, carried those sent to Bristol on their railway to London without charge. To Mr. George Rennie, the eminent engineer, the inquiry is especially indebted. This gentleman not only lent a tubular boiler, gratuitously, to enable the experiments to be repeated on this kind of boiler, but he also offered his premises for the prosecution of the experiments, which offer was accepted, until the larger space at the College for Civil Engineers was placed at the disposal of the investigation.

Such ready and liberal co-operation of the public shows their appreciation of the important practical results which may be expected from these experiments. Seeing the present effective state of the boilers and other apparatus erected at Putney, consequently, that the expenditure on this account has been incurred, and that any further charges for continuing these investigations would chiefly consist of payments of salaries to the persons employed as assistants, we would suggest for consideration, that these experiments may be extended to the coals of other districts than those the coals from which have been examined, and that the needful expenditure may be sanctioned for one or two years more. Should this be deemed advisable, we should anticipate that a most important body of information would be accumulated, alike important to the naval service and the public at large.

H. T. De La Beche.
Lyon Playfair.

ABSTRACT OF APPENDIX—TEST APPARATUS.

For drawing samples of the gases, the products of the combustion of the coals, a simple arrangement was adopted. A series of glass tubes, narrowed at each end, were connected together by caoutchouc tubes, and introduced into the iron tube of the chimney. The other end of the system of tubes was connected with a gas-holder filled with water. On opening the stopcock of the gas-holder, connection was established between the chimney and the former, and a current of the chimney gases flowed through the tubes. After this had continued for some minutes, so as to expel the air, the caoutchouc joints were tied and the tubes removed. Their contracted parts were afterwards sealed by a blowpipe's flame, and laid aside for analysis.

The method adopted for analysing the products of combustion belongs more particularly to the chemical part of the investigation, and will not, therefore, be described in this place.

The dew-point was taken at about the middle of each day's experiment, by means of a Daniell's dew-point hygrometer. The situation chosen for the observation was at the end of the boiler-house, farthest removed from the boiler, and the instrument was placed on a small wooden ledge, fixed against the wall at such a height as to bring the bulb of the instrument on a level with the observer's eye.

The two observations seldom gave a difference of 1°, in most cases much less.

Method of testing the Cohesive power of the Coals.

For this purpose a wooden cylinder was employed 3 feet in diameter, and about 4 feet long, each end having a bearing or gudgeon attached to it, on which the whole was made slowly to revolve. In the interior, three shelves tending to the axis were fixed, each being 6 inches in width: they were for the purpose of forming a lodgment for the coals, and of carrying them up towards the top of the cylinder during its revolution, thus insuring a certain amount of fall. An aperture was made at one end for the purpose of putting in the coals and for taking them out, which was closed, and rendered perfectly dust-tight by an oak door, firmly secured by an iron bar and staple. The cylinder was supported by a tressle at one end, the other gudgeon resting on a block let into the wall, and motion was communicated by a band passing round its circumference.

The coals to be tested were first broken to the size always employed in our experiments on their evaporating power, and then thrown on a sieve, the meshes of which were one inch square. Of the coals left on the sieve 100 lbs. were taken and put into the cylinder, which was then turned a certain number of times.

The whole was then allowed to rest a short time for the dust to settle, when the door was opened, and the coals again thrown on the same sieve, and the weight of coals remaining in it gave the per centage of large coals found in the Tables.

The values given in the Tables are the mean of two trials with each coal, with fifty revolutions.

The box in which the coals were weighed for supplying the fire, and also to obtain the economic weight, was 2 feet long, 2 feet wide, and 1 foot 6 inches deep, and consequently contained 6 cubic feet. The large coals were reduced to pieces, not exceeding 1 lb. weight previous to weighing, and this was the maximum size employed throughout the experiments.

Method of conducting the Experiments.

Having described the boiler, and apparatus connected with it, we have now to state the course pursued in conducting the experiments.

Let us suppose the water in the boiler to be cold, and to stand about 1 inch below the normal level. The fire was lighted, and any coals that might be conveniently employed to get up the steam in the afternoon of the day preceding the commencement of the experiments. As soon as this was the case, the fire was allowed to burn out, when the fire and ashpit doors, as well as the damper, were closed.

The next morning the first thing done was to open the safety-valve, to equalize the external and internal pressures, and then sufficient water was let down from the tanks to raise that in the boiler to the normal level.

The depth of the water in the tanks was then gauged, and the first observation of its temperature made. The ashes, cinders, and soot were next cleared out, and after noting the temperature of the water in the boiler, the fire was lighted with a weighed portion of wood, and the exact time was then observed.

The coals were then gradually added till the fire was of the proper size and form. The form of fire was slightly varied according to the kind of coal employed, our object being to burn the coal to the best advantage, with as little smoke appearing at the chimney-top as possible.

The observations of the temperatures of the two side and escape flues, and of the water in the tanks, then succeeded each other at regular intervals of about an hour each.

When the steam raised the safety-valve, the time was observed and entered under the heading "Steam up." The damper was adjusted as soon as the fire was sufficiently established, and was not disturbed during the day, except under peculiar circumstances.

When by evaporation the water had sunk 1 inch below the normal level, the deficiency was supplied from the tanks above: this was the plan pursued at first, but latterly we found it more convenient to allow the water to flow in continuously, so as to maintain the water in the boiler at a constant level, which was easily accomplished after a little experience.

In the management of the fire, care was taken to supply the coals in pieces not exceeding 1 lb. in weight, and in quantities of not more than one or two shovelfuls at a time, spread evenly on the fire, except in the cases of the anthracite and some of the bituminous coals. In the case of the anthracite, it was found that the sudden application of heat caused the pieces to split, and fall through the bars, and hence a gradual heating on the dead-plate was beneficial. With the bituminous coals a preparatory process of partial caking on the dead-plate prevented them from caking in the fire, which would have impeded the passage of air through the grate, besides giving better opportunity for burning the smoke and gases, by passing them over a large surface of ignited fuel.

The duration of the experiment was reckoned from the time the steam was up to about that of the last application of fuel, after which the fire was allowed gradually to burn out, when the damper, and furnace, and ashpit doors were closed.

During the day the ashes were thrown up in small quantities from time to time, when the fire was burning clear and well.

The weight of coals consumed was then ascertained, by deducting the weight left from the gross weight provided for the day's trial, and the experiment terminated.

The next morning, when the level of the water in the boiler was adjusted by turning down a supply from the tanks, their depth was gauged, and the quantity evaporated the previous day was thus ascertained. The ashes and cinders were then removed; the clinkers, if present, separated; and the weight of each taken. The soot was cleared out at the end of the last day's experiment, and the total weight recorded, which, divided by the number of trials, gave the average weight.

Samples of the ashes, cinders, and soot, were then put aside in bottles, for the purpose of ascertaining the per centage of combustible matter present in the residue.

The barometer was observed at about 11 o'clock in the day, being generally about two hours after the steam was up.

Method of estimating the quantity of Combustible Matter in the residue.

This consisted in heating the powdered substance in a stream of oxygen gas, by which the organic matter was dissipated chiefly as carbonic acid and water, and estimating the loss as combustible matter.

For this purpose a piece of German glass tube, four inches long, and half an inch in diameter, was drawn out at one end to a small orifice, which was then loosely obstructed by a piece of asbestos. It was then weighed, and again after the introduction of a small quantity of the substance; after which it was attached to the cock of an ordinary gasholder filled with oxygen, by means of a piece of glass tube and a cork.

A lamp was next placed under the tube, and the powder in it gradually heated up to incipient redness; when this was the case, the cock was opened, and a slow current of oxygen was made to pass over the heated material. Combustion then commenced, and was continued till the organic matter was entirely consumed; the gases escaping at the extremity of the tube, and the asbestos at the same time preventing the possibility of any of the powder from being carried away mechanically by the current; the cock was then closed, and the tube allowed to cool. When cold it was weighed, and from the loss it was easy to calculate the per centage of combustible matter, which is given in the Tables.

It was found advantageous not to reduce the ashes, &c., to a very fine powder, for when in that state the high temperature caused the fusion of some of the inorganic substances, which prevented the complete combustion of the organic matters, by defending them from the action of the stream of oxygen.

Great pains were also taken to obtain water of uniform temperature in the boiler, but the method of doing so would not be readily understood without the help of the engravings.

Section II.

Comparison *between the Effects produced by the Boilers at* Par Consols Mine, *and those obtained from that employed for the purposes of the foregoing Investigation.*

A large amount of facts relative to the evaporative powers of various coals having been amassed during the progress of this inquiry, it was thought desirable to ascertain how nearly these results approach the maximum duty obtained from Cornish boilers, and thus furnish a means of comparison between the apparatus employed for the purposes of this investigation, and larger boilers, of similar construction, as used for practical purposes.

Experiments have at different times been made in order to ascertain with accuracy the quantity of water which can, under the most favourable circumstances, be evaporated from a given temperature, by the combustion of 1 lb. of coal.

No very decisive results appear, however, to have been arrived at; as, on consulting those of the different experimentalists, considerable differences will be observed. Smeaton, who seems to have been the first to pay serious attention to this subject, found, in the year 1772, that 1 lb. of Newcastle coal evaporated 7·88 lbs. of water from 212° Watt, who turned his attention to this subject in the year 1788, arrived at the conclusion that 8·62 lbs. of water might be evaporated from the temperature of 212° by 1 lb. of the coal employed in his experiments; whilst Mr. Wicksteed, in the year 1840, found that 1 lb. of Merthyr coal could be made to evaporate 9·493 lbs. of water from the temperature of 80° Fahr., which is equal to the evaporation of 10·746 lbs. from the temperature of 212°.

Some experiments were also made about this time on the boilers of Loam's engine, at the United Mines in Cornwall, to which was adapted an apparatus which correctly measured the quantity of water injected into the boilers. The experiment was continued six months; and dur-

ing that time it was found that 234,210 cubic feet of water, at the temperature of 102° Fahr., had been pumped into the boiler, and that 700 tons of coals had been consumed in its evaporation: thus showing that 15 cubic feet of water at 102°, had been evaporated for each 100 lbs. of coals used; or that each pound of coals consumed, had evaporated 10·29 lbs. of water from the temperature of 212° Fahr.

It will be observed that these results not only differ considerably from each other, but also that no means was employed for the purpose of ascertaining the chemical composition of the various coals used, which should, we conceive, form an important part of all such investigations. In order, therefore, to obviate this inconvenience, as well as to take advantage of such improvements as may have been introduced since the dates of the foregoing experiments, it was determined to make a similar inquiry into the evaporating powers of the boilers of one of the best Cornish engines of the present day. That chosen for this purpose was the large pumping-engine at Par Consols Mine, where every facility was afforded by Mr. West, the engineer, for carrying on the experiments effectually. This engine is an 80, with a 12-foot stroke in the cylinder, and is worked by two boilers,* to which is added an arrangement by which the feed-water is heated to near the boiling point before entering the boiler. This is effected by means of the waste heat escaping from the flues; and the apparatus consists of two wrought-iron tubes, each about 20 inches in diameter, placed above each other, and parallel to the axis of the boilers, in the brickwork of which they are enclosed. The feed-water is pumped into the upper tube by means of the usual arrangement, and then descends through a pipe into the lower one, from whence it passes into the boiler itself. Both these tubes are exposed in their whole length to the action of the heated gases coming from the fires, which, after having made the circuit of the boilers, pass round the warming tubes before arriving at the base of the chimney; the water in the tubes is thus heated to about 212° by means of the heat absorbed from the gases passing through the flues, and of which the temperature is reduced to about 300° by the time they arrive at the base of the chimney. Our experiments were conducted in the following manner:—

It was first necessary to be enabled to measure with accuracy the quantity of water supplied to the boilers; and in order to effect this, a large cistern was placed near the air-pump, from the cistern of which it could, by a simple arrangement, be filled with water. The connecting pipe between the feed-pump and air-pump cistern was then removed, and a pipe fitted to the feed-pump, which reached the bottom of the reservoir. The cistern was also provided with a waste pipe, which prevented its being filled beyond a certain point; it was then filled with water and pumped out, in order to ascertain at what level the pump ceased to act. This point being decided, water was weighed into the cistern until it reached the level of the waste pipe before mentioned, when it was found to contain 1260 lbs. It was also necessary to be enabled to stop the action of the feed-pump during the filling up of the cistern; and this was accomplished by means of a stopcock placed in the feed-pump immediately under the stuffing-box, which, when opened, let in air and prevented the formation of a vacuum.

The measurement of the injected water was thus rendered excessively easy, as it was only necessary to count the cisterns pumped into the boilers, and open the stopcock whilst it was being filled, in order to do so with accuracy.

The arrangements for measuring the water having been completed, the experiment was begun; and at the expiration of 46½ hours it was found that 95 cisterns of water† had passed into the boiler, and that 11·730 lbs. of coals had been consumed; or, in other words, that 11·730 lbs. of coals had been consumed in order to evaporate 119·700 lbs. of water from the temperature of 92° Fahr., which gives 10·204 lbs. of water evaporated from that temperature for every pound of coal consumed. If, as in the former part of this Report, we take 212° as the standard temperature, we find that each pound of coal employed had evaporated 11,428 lbs. of water from the boiling point.

The combustible employed during this experiment consisted of a mixture of Swansea and Bury coal; but in what proportion, or from what pits, we were unable to learn. An analysis of the mixture was, however, made by my colleague, Mr. H. How, who obtained the following results:

Carbon	84·19
Hydrogen	4·19
Oxygen	0·86
Nitrogen	0·80
Ash	8·06
Sulphur	1·90
	100·00

* The boilers on which this experiment was made are each 32 feet in length, and 6 feet 3 inches in diameter. Each boiler presents a heating surface of 950 square feet, and the warming apparatus offers a surface of 560 square feet to the action of the heated gases.

† We took care to assure ourselves, by means of the guages, that the boiler contained the same quantity of water at the beginning and close of the experiments.

These coals were also found to contain 6 per cent. of water, the greater portion of which had been intentionally added, for the purpose of communicating intensity to the heat obtained during their combustion.

Having now ascertained the quantity of water evaporated by 1 lb. of coals, as well as the composition of the coal employed, it remains to institute a comparison between the evaporative capacity of the boilers experimented on, and that employed for the purposes of this inquiry. In order to have done this, it would have been desirable to have made a comparative experiment with the same coal when consumed in the latter boiler, but as circumstances prevented this from being done, we may obtain nearly the same results by consulting the Table of Analyses, and selecting a coal having as nearly as possible the same composition as that in question.

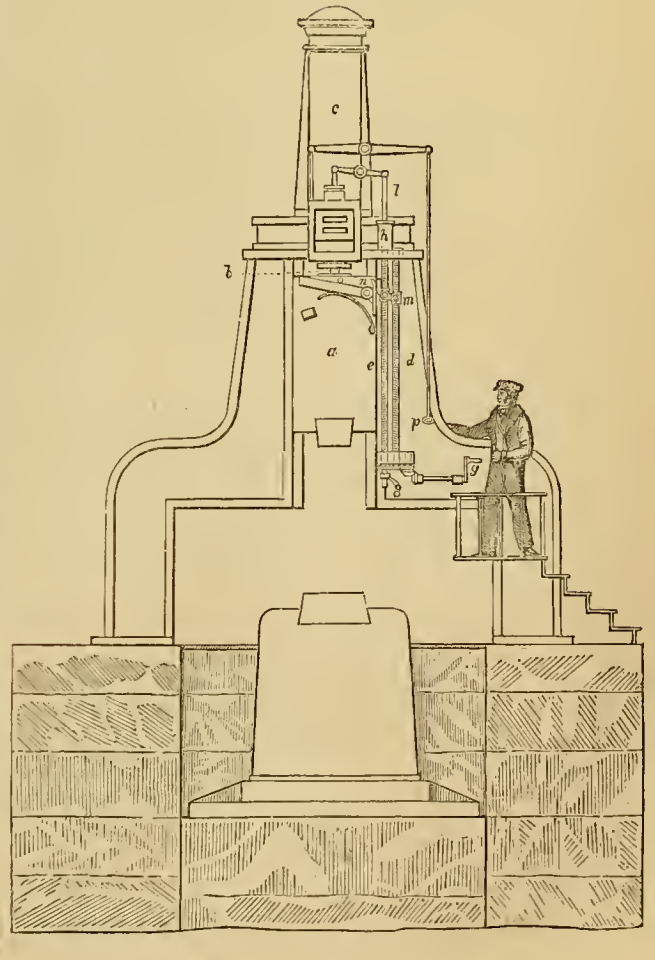
PRACTICAL INGENUITIES.

SELF-ACTING APPARATUS OF NASMYTH'S STEAM HAMMER.

The steam hammer, as originally constructed by Mr. Nasmyth, was not self-acting, each stroke being made by an attendant through handgear fitted to the steam-valve for the purpose. The practical working of the invention soon showed that the arrangement was by no means fitted for the full development of its power, and Mr. Nasmyth was early led to devise means of rendering the blows independent of the attentions of the workman.

The conditions to be fulfilled by a self-acting apparatus were, that the height to which the hammer rose should be capable of adjustment, in order to have complete command over the power of the blow; and that, the instant the blow was struck, the hammer should again rise, so that no loss of time should ensue. In addition to the direct loss of time occasioned by the resting of the hammer upon the mass of heated metal beneath it, another disadvantage was speedily discovered, namely, that the

Fig. 1.



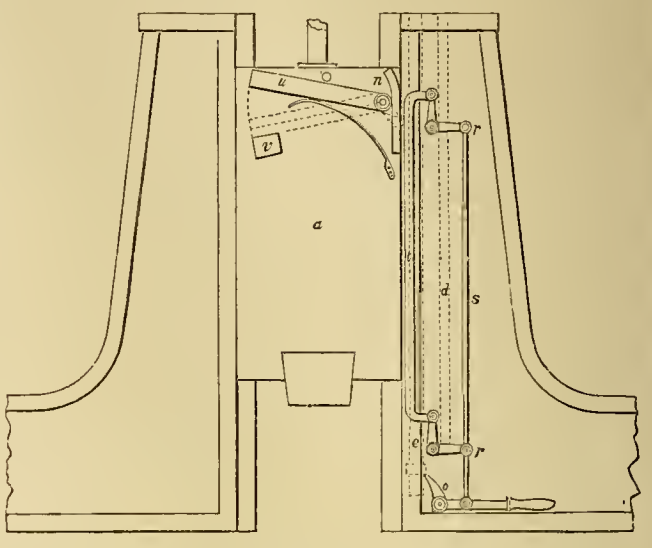
cold hammer face carried off a great amount of heat from the metal, thus neither turning "a heat" to the best advantage, nor retaining the material sufficiently long in a workable state. The peculiar difficulty of insuring a true automatic arrangement will be recognized, when it is considered that the instant of percussion must vary with almost every blow that is struck, for the bar gradually becomes thinner by hammering; and in a flat bar, a blow is first given on the flat side, and then on the edge, the difference in the fall of the hammer in the two cases being often several inches; and, further, that the hammer must be under instant control at all times.

As illustrations of the practical ingenuity displayed in the apparatus which has so successfully answered these conditions, we have engraved two separate drawings of it, so as to give a clear explanation of the two main objects which it serves. Fig. 1 is a side elevation of the whole hammer and foundations, as fitted with so much of the automatic mechanism as relates to the regulation of the height to which the hammer rises. *a*, is the hammer represented at the top of its stroke; it is attached by the rod, *b*, to the piston of the steam cylinder, *c*. Two long right and left-hand threaded screws, *d e*, are adjusted in bearings carried by the main frame, and are connected so as to work together by spur pinions on their lower extremities. At *g* is a handle, attached to a short spindle carried by two studs on the frame, and connected to the two screws by means of a pair of mitre wheels, driving a third spur pinion in gear with that on the right-hand screw shaft. The screw, *d*, has no motion in the direction of its length, but the screw, *e*, has a limited movement vertically, independent of its rotatory one. At *h*, the latter screw passes through a box attached to the top of the frame, which contains a powerful helical spring, acting so as to press the screw *downwards*. The top of the screw is connected by a swivel-joint with a rod, *l*, which again is jointed to one end of a double lever working the slide valve, which admits the steam below the piston. Each screw is fitted with a nut, as at *m*, and to these nuts a short double lever is attached. A pin on the nut of the screw, *d*, acts as a fulcrum for the outer eye of the lever, and as its contrary extremity is raised by the guard, *n*, of the hammer, the screw, *e*, is raised also to the extent of its vertical motion, which it communicates to the slide valve. When the screw, *e*, is raised, the detent, *o*, falls beneath the collar at its lower extremity, and prevents its return until the detent is removed by the apparatus yet to be described.

The attendant, standing on the platform as shown, communicates a rotatory motion to the two parallel screws, *d* and *e*, so as to elevate or depress the nuts, *m*, and lever, at pleasure; the nearer the lever of the nuts is brought to the bottom of the screw, the less will be the height to which the hammer will rise, as its guard, *n*, will so much the sooner meet the lever on the nuts, *m*, and thus raise the screw, *e*, and, as before described, close the steam port and open the eduction, when the hammer of course falls. The detent, *o*, by falling beneath a circular collar, does not at all impede the rotatory movement of the screw, *e*, although it prevents its descent so long as it is in action. The handle, *p*, communicates with the throttle valves in the steam and eduction pipes, and serves to vary the speed of the blows and their force; the less the exit, the slower the hammer descends; and, in like manner, the smaller the induction port is made, the slower it rises.

In fig. 2, the details connected with the detent, *o*, are represented on a scale double the size of fig. 1; the position of the screws, *d* and *e*, are indicated by the dotted lines to the right, the whole of the parts here represented being arranged to work behind the screws, and between them and the frame. Two bell cranks, *r r*, working loosely on studs carried by the frame, have their horizontal arms connected by a vertical rod, *s*, and their vertical arms by the bar, *t*, bent at a right angle at each end; thus, in whatever position the bar, *t*, may be placed, its direction is always parallel to its former position. The lower end of the rod, *s*, also communicates, by means of a short lever, with the detent, *o*, so that any lateral motion of the bar, *t*, liberates the detent from the collar on the screw, *e*, and permits the latter to descend. A bar, *u*, is fitted to oscillate loosely near one end, on a stud on the face of the hammer, *a*, placed close to the guard, *n*. The free extremity of this bar is loaded with additional weight, and is retained in the position represented, by a spring placed below it, its upward motion being restrained by a pin screwed into the framing above it, whilst the stop, *v*, prevents its descent below the point at which it is fixed. The end of the bar, *u*, next the guard, *n*, is bent downwards, and works through a slot in the guide, against the bar, *t*. The action of the bar, *u*, which is the moving power of the whole, is as follows:—As the hammer descends, every portion of it acquires momentum, and when the shock of the blow puts a sudden check upon its movement, the bar, *u*, having its momentum stored principally at its free weighted end, overcomes the resistance of the spring below it, and, moving on its centre, the bent extremity shifts the bar, *t*, laterally, and releases the detent, *o*. This action may take place at any portion of the bar, *t*, for, as it always moves in a parallel direction, it is immaterial at what point the force is applied; and thus, at whatever portion of its fall the hammer may be stopped, the momentum of the bar, *u*, brings the latter down; the bar, *t*, is moved laterally, and the detent, *o*, being thus removed, the reaction of the helical spring in the box, *h*, assisted by the weight of the screw, *e*, opens the steam-valve to admit steam under the piston; and the hammer consequently rises until the guard, *n*, meets the end of the lever

Fig. 2.



carried by the nuts, *m*, of the screws, *d* and *e* (see fig. 1). This movement then changes the position of the slide valve, as mentioned in the description of fig. 1; the steam escapes from below the piston, and the detent, *o*, falls again beneath the collar of the screw, *e*, ready for the succeeding blow.

A handle on the short lever of the detent, *o*, brings the latter within reach of the attendant on the platform, who has thus the whole machine under easy control, and is in a suitable position for directing the motion of the forged mass, whilst he can exactly apportion the power to the work to be done, and the state of the "heat." When it is desired to lessen the force of the blow, the steam is admitted *beneath* the piston, just before the hammer reaches the mass upon which it acts, so that a cushion of steam is interposed to partially sustain the force of the blow, and modify it for any particular purpose; and so exactly does this answer the end, that the hammer may be arrested in the most perfect manner when its face is no more than one-tenth of an inch from the anvil.

The steam employed as the moving power of the hammer-piston being of great pressure, the steam-valve requires considerable power to move it, and for this reason the hand-gear connection is not generally made direct to the valve-rod, as we have shown it. By the adoption of a small secondary cylinder, the steam itself is pressed into service for the valvular action. A small inverted cylinder is placed over the valve-chest, and the valve-rod becomes the piston-rod of this *cylinderette*, the small steam-valve of which is the one acted upon by the apparatus we have illustrated; the action of the steam on the small piston works the main valve, but the principle being identical in both arrangements, we have not thought it necessary to introduce this detail.

The peculiarly happy arrangement whereby the momentum of the machine is here taken advantage of, gives to the contrivance the rank of one of the most elegant pieces of practical mechanism; and although the combination of the whole bears the appearance of complication, yet a comparison of the difficulties of the problem with the parts required for its perfect solution, gives us every reason to admire the ingenuity which accomplished the desired result within such reasonable limits.

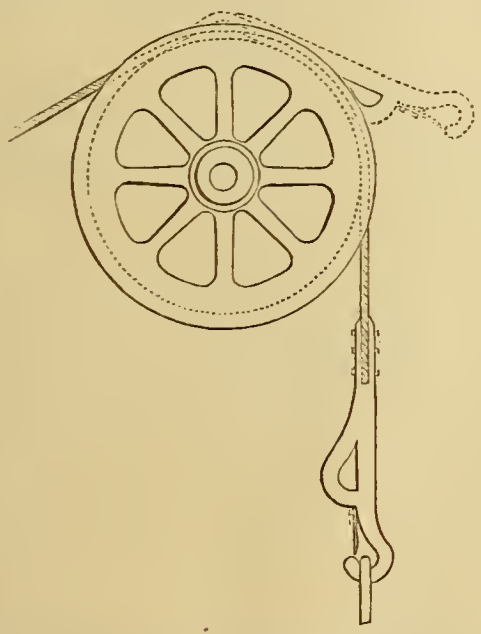
In the earlier constructed hammers, the top of the cylinder was directly open to the atmosphere, but in all those now in operation it is closed. The confined air plays the part of a spring, and the hammer, being raised with considerable velocity, acquires a violent rebound, which not only adds very materially to the power of the blow, but increases the rapidity of the action, insomuch that the most tremendous strokes are given in such quick succession, that the hammer may be fairly said to flutter on the anvil. D.

MINING IMPROVEMENTS.—DETACHING CATCH FOR THE PREVENTION OF OVER-WINDING.

The pnhlic papers of the day have lately chronicled a pretty long list of casualties resulting from over-winding, and. whether owing to carelessness or the inefficient state of the pit machinery, it is a well-ascertained fact, that the loss of life attributahle to accidents of this nature is immense. The ordinary winding apparatus is of the simplest kind. A steam-engine is planted in a wooden house near the mouth of the pit, and its crank-shaft forms the axis for the large winding pulley, the rope from which passes to a snpporting guide-pulley surmounting a species of conical timber stage over the shaft. Thus arranged, a comparatively slight motion of the steam-engine makes a very material change in the position of the pit cage, and a single stroke more than usual will in some eases be productive of disastrous consequences, hy carrying up the cage to the top pulley, where either the rope breaks, or the cage turns over.

Although mining engineers have long turned their attention to the devising of means for the prevention of mishaps of this nature, no greater result has been yet arrived at thau the putting up of complicated mechanism, and the early discovery of its utter inutility in practice. The beautifully ingenious schemes from time to time appearing, are seldom capable of standing the hard usage involved in mining operations, where simplicity of detail must ever he the chief aim of the engineer.

Since the execution of our engraving of Simpson's safety winding-catch, given at page 58, for June, the inventor has added a clever detaching-hook to he worked in connection with it, for the prevention of over-winding. The annexed figure represents a side elevation of the



hook, on the same scale as the drawing just referred to, namely, ½ inch to the foot. The modification is nothing more than the addition of a curved piece of metal welded on the shank of the hook at a short distance above its entrance. Should the cage be in danger of getting on the top pulley, the enrved piece, getting on the periphery of the pulley, causes the hook to take up the position represented by the dotted lines, when the cage-link will be released from the hook by slipping over its entrance.

It is evident that this design can only he put in action in connection with a stopping catch for snpporting the eage when the suspension rope is withdrawn, and it is in connection with the catch, given at page 58, that the inventor has secured it under the Registration Act. The plan is simplicity itself, and eannot fail to act properly when the projection gets on the pulley; hnt it may be remarked, that in a perfect contrivance of the kind, the cage should always he stopped at the proper height, independent of the look-out of the engineman. We observe that a plan for this purpose has just been submitted to the Royal Scottish Society of Arts by Mr. W. Alexander, of Summerlee Iron Works. Mr. Alexander proposes to wind entirely by friction; and by attaching a self-acting apparatus, he prevents the possibility of the rising of the cage above the height intended. We are not in possession of the details of the mechanism, but may probably be able to explain its action at some future period.

THE MARSEILLES CANAL.

One of the largest of the many engineering works now actively proceeding in France is the Marseilles canal, which is intended to connect the port of Marseilles with the river Durance. It commences near the town of Pertuis on that river, and it will have a length of 52 miles, of which 12½ miles will be underground work. Many obstacles lay in the way of the formation of a canal in this part, hut the skill of the engineer, M. de Montricher, has overcome them all, and the victory of mind over matter has been seldom more strikingly displayed. The canal, on leaving the Durance, strikes into the great plain of the Puy-Sainte-Réparado, passes behind the village of St. Estève by means of a deep cutting, becomes visible again near the fine ruins of the château de Janson, and crosses the departmental road from Aix to Cadenet, at an elevation of 45 feet. After leaving the ancient abbey of Sylvaraune, and the magnificent park of Roque d'Ambéron, it is supported near Charleval hy two splendid aqueducts. The Jacourelle aqueduct is 62 feet high, and 240 feet long; the Valbonette aqueduct is 292 feet in length, and has a height of 58½ feet. Near Verugens, the canal turns towards the south, and passes a chain of hills hy a tunnel of two miles and a quarter. This excavation was completed in the face of immense difficulty. A steam-engine of 100 horse-power was obliged to be employed to pump off the water. One spring alone threw up 15,000 gallons an hour, or 25 gallons a second. In the valley, and not far from the town of Lambese, the aqueduct of Valmonsoe, 98 feet high, and 550 feet long, receives the waters of the canal, and seems a piece of trial-work preliminary to the Roquefavour bridge, for the majestic proportions of the one are given in miniature in the other. The route then lies through the forest of Laburbeu, traverses the Aiguilles hills hy fourteen cuttings, and reaches the valley of the Arc, a little above Condom. It climbs this valley, rounds the mountain Ventahren, and meets with the immense defile of Roquefavour, which it steps across hy means of an aqueduct, 266 feet in height, and 1300 feet in length. Immediately afterwards, it traverses the valley of the Merindolle, then the road from Aix to Martignes, and at length reaches the Marseilles territory at St. Anthony, after having passed the chain of l'Etoile hy two borings, each upwards of two miles long. The canal is only visible to day for a very short distance hetween these two borings in the Assassin valley.

But amongst all the bold works of which we have given a dry enumeration, the bridge of Roquefavour alone may well suffice to perpetuate the name of its constructor; for M. Montricher has here undertaken a truly gigantic enterprise. The famous Pont du Gard, a work of the old Romans, still in existence in that neighbourhood, is a mere dwarf in comparison with the modern structure. The ancient aqueduct is only 153 feet high, and 650 feet long, but the aqueduct of Roquefavour is, as we have already stated, 266 feet high, and 1300 feet in length. The French point with great pride to this edifice, styling it the eighth wonder of the world, and asking, if, in dealing with the external features of nature at least, the genius of these times does not surpass that of ancient days. It certainly is a noble specimen of engineering; and the nearest approach we have made to it in this country is, we believe, the Ouse viaduct on the Brighton railway, which is 100 feet high, and upwards of a quarter of a mile long. In addition to its stupendous size, there are several other points of interest about this aqueduct for the traveller. The ground once shook beneath the tread of Roman legions: in these gorges took place many skirmishes preliminary to the great battle of Aix, when the consul Marius cut in pieces two hundred thousand Teutons and Ambrons; and thus these rocks, so auspicious to victory, acquired the name of "Rupes favoris," which the valley bears to this day under the corruption of Roquefavour. There are still traces of entrenchments and camps visible. The picturesque beauties of the neighbourhood, also, are interesting—rocks of rapid descent, pine forests, the Arc, (a pretty stream that foams along between the hills to the lake of Berre, an inland sheet of water which communicates with the Mediterranean,) long stretches of prairie ground, and, in the depth of one recess, an ancient Cistercian monastery, now but a little hermitage, whose clock sounds the hours with its clear voice from amongst vines and clematis. All these objects contribute to render the district one of great interest.

Into this nook, set apart, one might think, for silent meditation, come certain individuals, with compass and levelling stave in their hands; and these persons are heard to declare that Marseilles, the queen of the Mediterranean, is athirst—that, hy some means likely or unlikely, she must be relieved by the waters of the Durance; but there is an awkward abyss in the way. Nevertheless, a stream of water is made to cross that abyss, and a full cup is extended to the drooping people of Marseilles. Three tiers of arches are placed one upon another: the arches of the first pier have a span of fifty-six feet, and are twelve feet high; the arches of the second tier are about the same width, but not so high; and the highest

tier is made up of fifty-three small arches. In addition to the purpose for which this aqueduct has been designed, it is proposed to employ it also as a railway. A branch from the Aix line to the Marseilles and Avignon Railway will make use of this gigantic piece of masonry, which will thus not only bestride a river and bear a canal, but will see long trains of carriages flying across it. The first stone was laid by the corporation of Marseilles, on the 17th September, 1842. The first stone of the canal was laid by the late Duke of Orleans, Louis Philippe's eldest son, at the Marseilles terminus, 228 feet above the sea's level. The breadth of the canal at the surface of the water is almost thirty-five feet, and at the bottom about ten feet, whilst the depth is nearly seven feet. It is estimated that thirty-three cubic feet of water can be supplied per second. The total cost has been calculated at twenty-two millions of francs, or about £880,000 sterling.

In point of magnitude, perhaps many structures of the moderns excel any of the ancients; but the question of durability is a problem, the solution of which must be left to future ages. Meanwhile we may observe, that the hot haste with which enterprises of this kind are conceived, undertaken, and completed, is very different from the slow progress of past times. Fully believing in the everlastingness of their empire, the old Romans wrought as if they desired their edifices should endure as long; and accordingly,

They laid great bases for eternity.

MESSRS. THWAITES' CAMBRIAN LOCOMOTIVE.

Since our last notice of this novelty in railway engineering, it has undergone the test of actual work on the Leeds and Bradford line. A trip of some eighteen miles was made from Bradford to Skipton; we are not in possession of the full particulars of the speed attained, but the engine is stated to have behaved well, and, as a trial trip, was most successful. The Cambrian principle was first introduced for stationary purposes by Mr. John Jones, in 1841, who obtained a patent for the invention in that year. The arrangement of the stationary engine consists of a segmental cylinder, bolted down to a bottom plate, and fitted with a species of disc piston, disposed so as to vibrate throughout the length of the hollow segment of the cylinder. The shaft upon which the piston works, projects through a stuffing-box in the side of the cylinder, and carries an outside crank for giving motion to the fly-wheel shaft through a second crank and connecting rod. Messrs. Thwaites' application for locomotion is an improvement upon this arrangement. The rocking or vibrating shafts of the pistons are fitted with double levers, each end of which is fitted with a connecting rod passing to an outside crank on the front and central axles. In this way the pressure of the steam on the pistons of the central cylinders is carried off in opposite directions, so that the working strain is completely balanced, and great steadiness is obtained. The movement of the engine is highly elegant, as the vibratory action of the cylinder shaft, in connection with the continuous rotation of the driving wheel cranks, presents a beautiful appearance. Stationary engines on this principle have been very extensively introduced by Messrs. Crosley of Southwark, London, and good results have been obtained from them. For high speeds, as in a locomotive, we should be apprehensive as to the durability and accurate wear of the piston on the ends of the cylinder. Regular working will soon determine this point, and we shall watch the results.

OSCILLATING MARINE ENGINES, WITH THE "LINK" REVERSING AND EXPANSION MOTION.

Illustrated by Plates 6 and 8.

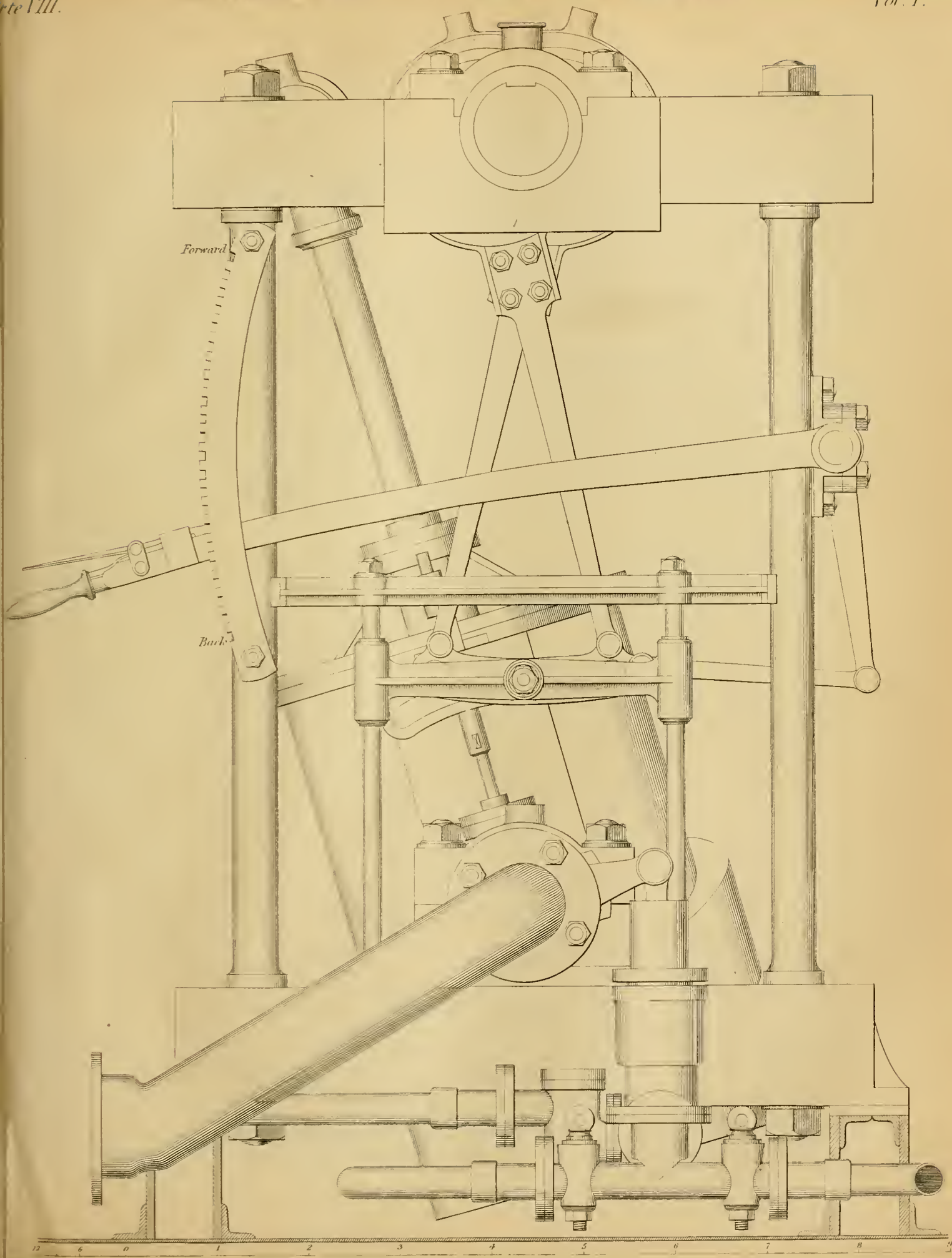
In further explanation of these engines, we have to refer to Plate 6, and the short introductory description given at page 58 of our last Number. Plate 8 contains a corresponding side view, and will be sufficient to illustrate the construction of the engines without any additional drawings.

The steam-valves are of the single cup kind, the steam being conducted to the top of the cylinder by a long passage cast in the cylinder side. The steam-pipe leading from the boiler is shown in front of the cylinder in Plate 8; and in Plate 6, the sectional portion on the right, exhibits its mode of fitting into the hollow cylinder trunnion by a brass gland. The valve-spindle passes upwards through a stuffing-box formed on the upper side of the trunnion, and has keyed upon it a transverse slotted link, the centre of curvature of which is coincident with the centre of oscillation of the cylinder; this link is continued upwards by a spindle, which works through a brass guide screwed upon the cylinder-top. This link is connected by a long stud with the expansion link, through which it is loosely passed; and being continued onwards, passes also through the centre of a horizontal guide-bar, fitted with deep eyes at each end to slide on the vertical guide-pillars, placed one on each side the trunnion. The stud, being fitted with a shoulder to bear against the inside of the guide-bar, is held firmly in the central eye by the nut on the outside. The centre line of the curved expansion link is struck with a radius equal to the length of the eccentric rod, measured from the centre of the eccentric, so that whatever angle the eccentric rods may form with the axis of the valve-spindle in shifting for the back or forward motion, or for expanding, the valve suffers no derangement, and in this respect the arrangement is similar to that now almost universally adopted in locomotive engines. The sectional view of the link and guide-bar, in Plate 6, clearly explains the action of the arrangement. The backward and forward eccentrics are placed side by side on the paddle-shaft, directly over the valve-spindle, their rods being bent so as to bring the double eyes on their ends into the same plane. Each rod is jointed by its double eye to projecting eyes forged on the expansion link at each end, the oscillatory movement of the cylinder being allowed for by the curved slot on the valve-spindle, playing over the connecting stud of the link, which is constrained to move vertically by the horizontal guide-bar. The back extremity of the expansion link is formed with an eye for the attachment of the reversing gear. The reversing shaft passes in one length behind both engines, being carried by pedestals bolted to the main pillars of the paddle-shaft, and carries two levers directly connected by a short rod with the back eyes of the expansion links. The reversing lever is represented in elevation in Plate 8; its handle is fitted with a spring detent, the end of which may be adjusted in any of the retaining notches on the segment bolted to the side of two of the main pillars. As this lever is now set, the engines are running backwards, with very little steam admitted to the cylinders, or, in other words, the valves are cutting off at a very early portion of the stroke. If the reversing lever is now pushed downwards until the detent of its handle arrives at the lowest notch of the segment, the expansion link will be drawn back until the front end of the slot in the expansion link comes upon the valve-stud, when the backward eccentric will give its full throw to the valve, and full steam will be admitted to the cylinder. If the lever is raised to a corresponding height above its horizontal position, the reverse will take place, and full steam will be admitted for a forward movement; and the horizontal position of the lever places the centre of the expansion-link upon the valve-stud, so that no motion is communicated thereto, and the steam is shut off.

The essential value of this arrangement consists in its unbroken motion, and the facility which the engines may be backed or slowed, an advantage of eminent service for crowded rivers, where considerable ingenuity is required in winding in and out amongst the shipping.

The exhaust steam from the cylinders is carried off by the inner trunnions, which are of the same construction as the outer ones, used for the induction passages of the steam. The spiral belt represented in both views, winding round the cylinder, conducts the exhaust steam from the cylinder port to the hollow trunnion, whence it passes by a short cast-iron pipe to the projecting top of the condenser. The body of the condenser is of an oval section, and has projections on its sides for resting upon the wrought-iron kelsons. The air-pump is furnished with a circular flange near the top, by which it is supported on the top of the condenser, its lower end being a little above the bottom of the latter. The air-pump piston is worked by a central crank formed out of the solid of the paddle-shaft. From this crank, a forked wrought-iron connecting rod passes downwards to a slide-block on the piston-rod top; the slide-block being fitted to work between two guide-bars bolted to the air-pump cover, and stayed at their upper end by bars springing from the paddle-shaft beams. The injection water is conducted into the condenser by two separate copper pipes, running along each side of the engines. These pipes terminate on opposite sides of the condenser in brass elbows, upon which the injection cocks are cast, the flanges of the latter being bolted to the sides of the condenser. In the interior of the condenser, and opposite the holes in connection with the injection cocks, short retaining socket flanges of brass are bolted for the support of the jet pipes, represented in Plate 6, in dotted lines. The jet pipes are curved to suit the internal shape of the rounded ends of the condenser, and are pierced with a series of narrow apertures, through which the injection water issues in thin sheets. By a simple linked connection, the two injection cocks are set to open simultaneously with one motion of the lever handle. The bilge pumps are worked in a simple manner by levers on the outer cylinder trunnions, thus taking advantage of the oscillatory motion of the cylinder for the purpose.

We cannot too strongly recommend this system of working the valves where stoppages are frequent, or where the intricacy of the navigation demands that close attention so frequently necessary in the rivers of this country. Mr. Hall informs us that the plan completely answers his expectations, and that a considerable economy of fuel has resulted from its use.


Forward
Back
12 6 0 1 2 3 4 5 6 7 8 9 Feet

ANATOMY OF THE PHYSICAL STRUCTURE OF THE UNIVERSE.

By Mr. R. Smith, Blackford.

II.—Light.

Next to the love of life, the strongest feeling implanted in the human breast, is the enjoyment of sight. Without light—the medium through which this enjoyment reaches us, the earth would appear little more than a rude chaotic mass; tangible objects, which now rivet the attention by their surpassing beauty of tint or combination of colours, would not be distinguishable from the common mass—the coal and the diamond would have equal claims upon our admiration.

The science which treats of light and vision, is, after the fashion of the earlier philosophers, indebted to a foreign language for its name, which is derived from the Greek word, *ὄπτομαι*, *I see*. In studying the character of light, its investigators have adduced three distinct theories—the emission, undulatory and electric. The first, which obtained the sanction of Sir Isaac Newton, is to the effect that light is composed of inconceivably small particles, so subtle that they do not exhibit any of the known properties of matter; that these particles are projected, in straight lines and in all directions, from various luminosities, such as the sun, planets, fixed stars, incandescent and phosphorescent bodies, with immense velocity.

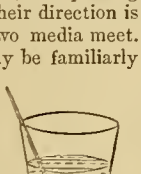
According to the undulatory theory, light results from the undulations or vibrations of a subtle etherial medium produced by luminous bodies, these vibrations having an effect upon the visual organs analogous to that occasioned by pulsations of air on the tympanum of the ear, in the production of sound. Among the early supporters of this theory, were Descartes, Huyghens, and Euler. After slumbering for a long period, it has been lately resuscitated, and Professor Airey and Sir John Herschel have signified their adhesion to it. The third, or electric theory, rests upon an hypothesis of the all-pervading nature of electricity—light being one of its modifications.

The undulatory theorists maintain, on their side of the question, that the phenomena of polarized light can only be explained on the principle of undulations; their antagonists again insist that the latter theory affords no grounds for the explanation of other phenomena, as crystalline reflection. Dr. Turner observes, in reference to the undulatory and emission theories, that "either of the two will serve the purpose of classifying facts, and explaining most of the phenomena, the advantage lying sometimes on one side, and sometimes on the other."

It was at one time supposed that light was propagated from luminous bodies instantaneously, but modern discoveries have shown us that its passage is progressive. According to Herschel, light travels at the rate of 192,500 miles in a second; Bardley makes it 200,000.

In discussing the science of optics as a whole, we must follow it out under the two main divisions of Dioptrics and Catoptrics. The term dioptric signifies to see *through*, and has reference to the transmission of light through transparent bodies; whilst catoptric means to see *from* or *against*, and refers to the formation of images and the reflection of light from surfaces. Each ray of light, when uninterrupted, and remaining in the same medium, moves in a straight line; hence the origin of shadows, or that dark spot which appears when an opaque object intercepts the rays of light, as when during the night we are shrouded in the dark shade of the earth.

As light advances from a luminous body, it diminishes in intensity, increasing proportionally in volume—the ratio of diminution being according to that which regulates physical forces, that is, with an intensity inversely as the square of the distance. If the rays of light, after passing through one medium, enter another of greater density, their direction is changed, and they appear bent at the place where the two media meet. This bending or diversion is termed refraction. It may be familiarly explained by the annexed figure, which represents a glass half filled with water, having a straight stick placed within it. Immediately on the immersion of the stick, so much of it as is below the level of the water appears to be bent at a considerable angle with its actual axis, as represented by the dotted portion from the surface of the water downwards. A coin placed in the glass exhibits a duplicate of itself, the copy or refracted image being uppermost; and if the coin is placed in a basin, and the observer walks backwards until he loses sight of it behind the edge of the vessel, he may bring it again into his line of vision by pouring water upon it. The rationale of this experiment is, that the rays of light producing vision in the eyes of the observer, are refracted on emerging from the water. The same phenomenon occurs to a large extent in our atmosphere: when the rays of the sun enter the atmospheric medium surrounding the earth, they are refracted at the junction of the upper etherial medium with our more dense stratum, and, owing to these effects, we never see the sun or any of the celestial bodies in the positions they actually occupy.



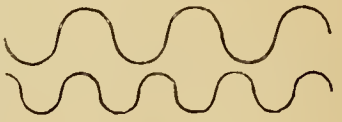
The variable conditions of the atmosphere are continually affecting our vision, and from the disturbances so occasioned arises the curious spectacle of the mirage. When an atmospheric variation takes place in a horizontal direction, perpendicular to the line of vision, an image of the object is seen on one side of the real substance; if the variation in the refractive power is the same on both sides of the line of vision, an image is seen on both sides of the object.

Various methods have been suggested by philosophers for the artificial representation of the mirage. Sir D. Brewster succeeded in producing it, by placing a heated iron above a quantity of water bounded by parallel plates of glass; as the water becomes gradually heated, a variation takes place between the density of the upper and lower surface of the water. If the heated iron is removed, and a cold body put in its place, the upper stratum of the water being heated, will give out a portion of its heat to the cold body, and, producing a decrease of density upon the surface, a medium is formed, through which the phenomena of the mirage is seen in the highest perfection.

The mirage is often seen to great advantage on the sea of Reago, and the sandy plains of Egypt. In 1822, Captain Scoresby observed a most interesting case, being the inverted image of his father's ship, which appeared suspended in the air. He says—"It was so well defined, that I could see by a telescope every sail, the general rig of the ship, and its particular character, insomuch that I confidently pronounced it to be my father's ship, the 'Fame,' which it afterwards proved to be, though, on comparing notes with my father, I found that our relative position at the time gave our distance from one another very nearly thirty miles, being about seventeen miles beyond the horizon, and some leagues beyond the limit of direct vision."

Some years ago this spectacle was often observed a little to the west of the village of Auchterarder in Perthshire, and at that time was termed the vision of the moor. The time of observation was generally a little before sun-rise and sun-set. Reflections of landscapes, towers, towns, and groups of men, were clearly made out by different individuals. For a long time past, nothing of the kind has been seen; and it is probable that agricultural improvement has had some share in preventing its recurrence, as, at the time to which we refer, the locality was a barren waste.

Philosophers have attempted to explain the production of colour on the theory of undulations. The ether within the refracting medium is condensed by the attraction of its particles, so that the velocity of the transmission of a wave of light is less than it is in space, and accordingly the direction of motion is changed, or, in other words, it is refracted; consequently, the various lengths of waves of different colours cause a refrangibility corresponding to these differences. Some idea of the variations of the waves or undulations of red and violet light may be formed from the annexed figure, where the upper series of curves represents undulations of red light, and the lower those of violet, pretty nearly in the proportions they actually bear to each other. In the evolution of red light, it is requisite that a body should communicate to ether at least 477 millions of millions of undulations, and to produce violet, 699 millions of millions must occur.



GAS-ILLUMINATION OF THE STAINED GLASS WINDOWS IN THE HOUSE OF LORDS.

However beautiful tinted glass appears when used as a transparency, it certainly presents a very uninviting exterior when examined as an opaque body; as, for example, in the House of Lords at night, when the brilliant lights of the inside reflect only a dark and rough surface of glass, as seen against the external darkness of the night. Those who have seen the "House" by daylight, when the brilliant colours of the glass are all brought out, can form no idea of the utterly ugly appearance of the same windows by artificial light, when they look like black patches of coarse cloth stuck against the walls. We are glad to hear that an important improvement is about to be made in this particular, so that the objectionable ugliness will not only be completely removed, but the effect of the designs on the glass will be decidedly improved. The improvement consists in lighting up the windows by gas on the exterior. Now any one may see, that by this arrangement, the removal of the dark background will give the glass its full transparent appearance, but it is

found by actual experiment that, by a nice adjustment of the exterior and interior lights, the ornaments and figures appear to be in relief. In this way the beauty of the windows is many times enhanced, as statues and sculptured devices of the most exquisite finish and colours start up on the application of the external light, adding greatly to the grandeur of the building, and converting positive eye-sores into magnificent displays of ornament.

The effect of the scheme may be seen in principle, (for it is quite impossible to describe it,) in the photometer proposed by Professor Bunsen, for comparing the relative intensity of two lights. This instrument is nothing more than a screen, semi-transparent in some parts; the lights to be tested are placed on opposite sides of the screen, and when the two bear a certain proportion to each other, something of the peculiar relievo effect is seen. D.

THE SEA.

The water which lies on the surface of the globe, and bears the names of Ocean and Sea, has in its superficial extent a proportion to that of land of about 27 to 10. Its principal masses are known as the Pacific Ocean, lying between America and Asia, and containing a countless number of small islands; the Atlantic Ocean, separating America from Africa and Europe; the Indian Ocean, comprised between Africa and Australia; and the oceans which surround the poles. All these communicate with one another, and with those minor expanses of water denominated seas, which look on a map like deep gulfs, such as the Mediterranean Sea and the Red Sea. The areas of water in the northern and southern hemispheres differ considerably, for there is a much larger extent of land in the former than in the latter. In the northern division there is about 72 per cent. of sea, in the southern only about 15. It was at one time supposed that, in order to the maintenance of the globe's equilibrium, there must be an undiscovered mass of land in the southern ocean, but no such conjecture has been verified.

The depths of the sea are as varied as the elevations of the land. The bottom in some places has never been touched with a sounding-line of 25,300 feet. Light does not usually penetrate deeper than about sixty feet, but of course much depends on the transparency of the water. The Caribbean Sea is remarkable for its clearness, and it is said that the bottom may be seen as deep as 150 feet; whilst, in the northern seas, it has been averred that the eye may penetrate through 400 feet of water. It is somewhat difficult to account for the variety of tints which the surface of the sea exhibits in different places. Something is due to the matter it holds in suspension, and to the animal and vegetable objects which float in it; something also to the reflection of the atmosphere, though it is to be observed that the ultra-marine colour seen at a distance from land is often of a deeper hue than the sky, and the circumstance of clouds does not make it change colour. In the Greenland Sea, between 74° and 80° N. lat., Scoresby tells us that there are long bands, lying north and south, of ultra-marine and olive-green—that the whales feed in the water of the latter colour—and that changes in the position of these bands take place. It is well known that in certain latitudes, especially between the tropics, there is a certain luminous appearance in sea-water. On a dark night, the water is full of brilliant flashes and sparklings; and even in the day-time, when the water is agitated by a vessel or any other cause, the same phenomenon, but in a subdued degree, is perceptible. A long furrow of light is frequently seen behind a sailing ship, and the edges of a breaking billow seem tipped with fire. This curious phenomenon is supposed to originate in a certain phosphorescence emitted from living animals of a minute form, or from animal matter undergoing decomposition.

There seems to be good ground for believing that portions of the globe's crust are being slowly elevated, and consequently, that the edges of existing ocean-basins are undergoing change. It is said that the coasts of Finland and Sweden are rising at the rate of four feet in a century. Again, the coast of Chili was suddenly raised in 1822, at a period when the country was disturbed by earthquakes. Lines of old sea-margins are now to be traced, by means of shells and other deposited matter, some hundreds of feet above the present level of the water. These raised beaches may be seen on the coast of Norway, and along a great part of the Scotch coast. On the other hand, the coast of Greenland is sinking. Some speculations connected with the formation of coral reefs in the Indian and Pacific Oceans have been connected with the secular rise and fall of large portions of the earth's surface. It is known that the coral animal only works at a small and measurable distance beneath the surface of the sea. In those oceans, an immense number of coral islands, rings, and reefs, are scattered over a vast area, and yet we can hardly believe that there are submarine mountains and ridges, rising to exactly the same height, through all that region. By supposing the land to subside slowly beneath the ocean, so as to give the coral animals time to continue their building operations upwards, some explanation is given to the strange circumstance of our finding their structures in such multitudes near the surface. Thus, a submerged island will produce a ring, and a barrier reef will be occasioned by a sunken coast or ridge. Arguing from general principles, it is inferred that the surface of the sea forms a regular curve, every point in which is equidistant from the earth's centre. However this may be with regard to great masses, several of the seas which are locked in by land must be excepted. The surface of the Mediterranean, for instance, is some feet below that of the Atlantic, and the consequence is, that a current sets into the former from the latter through the Strait of Gibraltar. The reason of the lower level of the Mediterranean may be found in the facts of the small supply of water brought into it by rivers, and the large quantity abstracted from it by evaporation. Not only is it necessary to be fed from the Atlantic, but it draws a constant stream from the Black Sea at its other extremity. About 70 miles of land separate the Red Sea from the Mediterranean, and it has been found that the former is about 30 feet higher than the latter, although no stream of any size falls into it, and the evaporation must be very great. This is not easily accounted for, unless we assume an error in the measurements. The Baltic Sea has a higher level than the North Sea, which it adjoins and flows into, the reason being the very large drain of river-water into the former. It is a phenomenon, however, less easy of explanation, that though the Pacific is separated from the Atlantic, at the Isthmus of Panama, by only 30 miles of land, there has been found a difference of some feet in their respective levels.

The temperature of the land increases the deeper we go, but the reverse of this takes place with regard to the sea. The decrease of temperature, however, is not everywhere in the same ratio, and yet the change is not connected with latitude. If the observations have been correctly made, their results offer some curious problems for solution. It has been found that the decrease of temperature is slow at first, then it grows more rapid, afterwards more slowly, until it becomes stationary. In particular localities of the Gulf Stream, the sounding-lead, after having been let down to a depth of 500 or 600 feet, came up so hot that the hand could not hold it. At a depth of between 100 and 200 fathoms, Scoresby found the sea, between Spitzbergen and Iceland, was nearly 7° warmer than at the surface—an anomaly not readily explained; for though melted masses of ice may bring a large quantity of cold water into that sea, one supposes that it would sink as being denser. The temperature of the atmosphere over land is always colder than that over the sea, and it is generally found that the temperature of the sea decreases as land is approached, so that the thermometer is frequently used as a means of indicating a vessel's approach to land or the neighbourhood of submarine banks. The temperature of the air resting upon the ocean is also much more uniform than that over land, being less subject to change, and the changes being of a less range. Between the tropics, the temperature of the sea, during 24 hours, hardly ever changes to the extent of 3°. In other latitudes, however, there is not quite the same degree of steadiness. Between the tropics, again, a very trifling difference in the temperature of the sea has been noticed throughout the year; but the farther we advance to the poles, the annual variation is greater. The southern hemisphere is colder than the northern, for it has been observed that the equator of temperature is between 0° and 5° N. latitude; that is to say, that whilst the decrease of heat commences in the northern hemisphere at 5°, in the southern it begins at the earth's equator.

Large masses of water are seldom still; they are usually traversed by currents, some of which have a breadth of two or three hundred miles, and extend to a distance of perhaps 3000. Such movements have been divided into drift-currents and stream-currents; the former being occasioned on the surface by the prevailing winds which drive the water before them in their own direction. Thus, in the Atlantic, the trade-wind produces such a current between the tropics, with a mean velocity of nine or ten miles in 24 hours. The cause of the stream-currents is more obscure. Although felt on the surface, they penetrate to a great depth below. In the Atlantic, there are two such currents: one, the equatorial current, runs under the line from Africa to South America, and when it attains to within 300 miles of the Brazilian coast, it divides into two branches, one of them running north along the Guiana shores, the other south along the shores of Brazil. The other great current of the Atlantic is that known as the Gulf Stream, which flows between the parallels of 36° and 44° N. latitude, from America to Europe. It begins to be perceptible in the Gulf of Mexico, from which it issues at the Strait of Florida with the extraordinary rapidity of four or five miles an hour. It then runs along the coast of the United States, as far as the 40th degree of latitude, and there, meeting with large banks, its heated waters are sent eastward into the main ocean; and they may sometimes be detected, from the temperature alone, on the coast of Europe, though their

motion ceases to he apparent near the Azores. The total length of this current is calculated to he 3000 miles, in the course of which it loses about 13° of temperature. Its strength is so great, that navigators sedulously avoid it iu sailing to Northern Europe, the more especially as the atmosphere iu its vicinity is subject to great storms; and, indeed, vessels whose course would he accclerated hy it in its more rapid parts, endeavour to get out of its reach for the reasou that tbe strain is so great as to damage them. In addition to these mighty oceanic rivers, there are two others which flow from the north towards the equator. The arctic curreut is supposed to he caused hy the melting of ice about the pole. The North African current originates hetween the south coast of Ireland and Cape Finisterre in Spain, makes for the African coast, and is lost somewhere ahout the mouth of the Quorra. Both these currents have a temperature lower than that of the surrounding ocean. In the Pacific Ocean, which is much less of a highway than the Atlantic, the currents have been less accurately observed. This immense expanse of water is the largest on the globe, of which it occupies one half in superficial extent. Here, again, the trade-winds form a drift-current; whilst a stream-current sets towards the equator from the south pole, and another, termed the Peruvian current, carries a hody of cold water in the opposite direction from ahout 38° south latitude.

These movements of the sea are only to he observed by those who actually visit the great deep; hut there is another movement which is familiar to all who have ever been on its hrink—we mean that of the tides. Whilst the theory of the tides is well known, the application of it to the actual state of things is exceedingly difficult, in consequence of the number of disturhing causes affecting the tidal swell, such as continents, winds, narrow channels, &c. The rise of the water in the shape of tides is due to the attraction of the sun and moon upon the mobile particles of the ocean, hut it is the moon whose influence is the greatest. We may best gain a general conception of the phenomenon hy imagining the globe to consist of a nucleus of solid earth, around which there is a coating of water of even depth. Now, the vicinity of another globe like the moon has the effect of drawing towards it a large mass of the water which we had previously supposed to he evenly spread over the surface of the sphere; and the principles of gravitation applied to a revolving body immediately cause the water to rise as well on that part of the sphere which is *opposite* to the moon. It results, then, that on the side of the sphere which is next the moon, and on the side which is most distant, the water is heaped up and deeper than elsewhere, the liquid having been drawn away from the other parts; and when we rotate the earth ronnd its poles, since a differeut position is every moment presented to the attracting hody, it is evident that the deeper mass of water will have a correspondingly different position with reference to the interior nucleus. Precisely the same phenomenon would occur hy keeping the earth steady, and making the moon perform a diurnal revolution round it, for the latter hody would draw the water after it, and thus the tidal swell would successively push its way over every portion of the earth in the line of the moon's influence. Two elevated swells, exactly opposite to each other, in order to the preservation of the equilihrium, will journey ronnd the earth in the conrse of a diurnal revolution. In confirmation of this, it will have been ohserved that there are two tides in abont 24 hours. Observations conducted for a few days will show that, in fact, there occurs an interval of 12 hours 25 minutes between each tide; in other words, each evening tide is nearly half-an-honr after the corresponding hour of the morning tide. This retardation is explained in this way:—Whilst the earth has been performing a revolution abont its poles, the moon has been advancing in its orbit; and hence any given fixed point upon the earth, reckoning from a culmination of the moon, after completing a perfect revolution, *i.e.* after the lapse of 24 hours, will still not have reached to a second culmination, hecause of the way the moon has made in its own orhit, and 25 minutes is required to do this. When the attractions of the sun and moon are exerted in or near the same plane, the tides are high; and when they influence different portions of the earth, then the tides are low—that is, spring tides and neap tides. With a view to the ready comparison of tidal phenomena at different places, charts have been drawn with lines passing through all the points where high tide occurs at the same moment.

The specific gravity of sea-water near the equator is ahout 1·0277, rain-water heing 1. Where large quantities of river-water are mixed with the sea, its water is lighter. It is curious that the quantity of salt varies considerably in different seas: thus the Baltic holds 1·18 per cent. of salt in solntion, whilst the Mediterranean has as much as 4·18 per cent. Common salt is the most abundant ingredient, the other ingredients being salts of magnesia, lime, and potash, with very minute portions of iodine and bromine. The amount of these matters in 1000 parts is not nsually more than 30 or 40 parts, but an analysis of the water of the Red Sea gave as much as 243 parts of saline matter in 1000. The peculiar nauseous taste of sea-water is derived from a slimy fetid matter, probably the decomposed particles of animal and vegetable substances diffused through it. The southern ocean contains a small portion more salt than the northern, but it is helieved that there is no difference between the surface and the lowest accessible depths; however, tbe brine is stronger at the greatest distauce from land.

THE MECHANIC'S LIBRARY.

Under tbis head, we purpose furuishing a montbly list of new hooks on subjects more or less connected with the professional pursuits of the Mechanic and Engineer, or their kindred arts. Our readers will thus have au opportunity of seeiug what is new in counection witb their several pursuits; and, in this particular, the provincial resident will be on a level with an iuhabitant of the metropolis. The catalogue helow, contains the principal portion of this class of works issued since the beginning of the present year:—

Algebra, Treatise on, 12mo. 1s. cloth. Rev. B. Bridges.
Ancient World, 2d edition. Prof. Ansted.
Animal Body, Motion of the Juices in the, 8vo. 5s. cloth. Dr. Liebig.
Architecture in Engineering, Styles of, 5th edition, 8vo. 21s. cloth. T. Rickman.
Architectural Parallels, fol. £13 13s. half-morocco. E. Sharpe.
Architecture, Peep into, illustrated, 2d edition, 16mo. 4s. Eliza Chalk.
Arithmetic, Utility of, 7th edition, 18mo. 1s. 6d. boards. R. Chambers.
Astronomy, Earth and Heavens displayed, &c. foolscap, 2s. cloth.
Atlas of the Earth, new edition, imp. 4to. £2 12s. 6d. Gilbert.
Astronomy, Treatise on, 3d edition, 12mo. 4s. cloth. E. Henderson.

Bibliopegia; or, Art of Bookbinding, 4th edition, 4s. 6d. J. Hannetts.
Box of Instruments, Treatise on, 2d edition, 12mo. 4s. 6d. Kentish.

Calculus, Treatise on, 8vo. 9s. boards. G. W. Heming.
Caledonian Canal, Pictorial Hand-Book to, foolscap, 2s. 6d. cloth. Sylvanus.
Canals, Hope for the, 8vo. 1s. sewed. T. Boyle.
Carpentry and Joinering, a Guide-Book for, vol. i. 4to. 25s.
Chemistry, Manual of, 6th edition, enlarged, 2 vols. 45s. W. J. Brande.
Chemistry, the Simple Book of, 8vo. 9s. cloth. D. Low.
Chemical Analysis, Qualitative, 8vo. 16s. cloth. H. Rose.
Chemistry, Treatise on the Elements of, new edition, 4s. 6d. cloth. S. Parkes.
Colonial Wools, Present State of, 8vo. 12s. cloth. T. Southey.
Crystallography, Elementary Treatise on, 8vo. 3s. cloth. V. Regnault.
Cultivation and Manufacture of Tea in China, 8vo. 14s. J. S. Balls.

Decorator's Assistant, vol. ii. royal 8vo. 5s. cloth.
Differential Calculi, Treatise on, 8vo. 13s. boards. Rev. B. Price.
Draughtes for Glaziers, Booke of Sundry, 8vo. 16s. half-bound. W. Gidde.
Draining, Manual of Practical, 3d edition, 8vo. 5s. cloth. H. Stephens.
Drawing, Elements of, 10 Plates, oblong 4to. 3s. sewed. T. J. Rawlins.

Encyclopædia of Manufactures and Machinery, 4to. 42s. cloth.
Encyc. Met. vol. v. The Encyclopædia of Astronomy, 4to. 21s. cloth.
Encyc. Met. vol. ix. Encyclopædia of Experimental Philosophy, 31s. 6d.
Engineer's Common-place Book, 3d edition, 12mo. 5s. cloth. Templeton.
Engineer's Railway Guide, part 2, 8vo. 21s. cloth. W. D. Haskoll.
Euclid, Elements of Books 1 to 6, 10th edition, 8vo. 6s. cloth. Lardner.
Euclid, Symbolical, 8th edition, 18mo. 6s. 6d. cloth. Rev. J. M. Williams.

Farmer's Library of Animal Economy, vol. i. royal 8vo. 17s. 6d. Knight.
Field Fortification, 2d edition, 12mo. 12s. cloth. J. S. Macaulay.
Fine Arts, Contributions to Literature of the, 8vo. 12s. Eastlake.

Gas, on the Domestic uses of, 12mo. 3d. sewed. A. A. Croll.
Geography of the United Kingdom, Synopsis of New, 2s. 6d. Mangles.
Geography, First Lessons in, 18th edition, 18mo. 9d. sewed. Allison.
Geography and Globes, Guide to, maps, 2s. Butler.
Geography, Physical, 2 vols. foolscap, 12s. cloth. Somerville.
Geography, Progressive, 2d edition, 18mo. 2s. cloth J. R. Hiley.
Geology, Sketches of, No. 13 of Small Books on Great Subjects, 3s. 6d.
Geology, Wonders of, 6th edition, post 8vo. 18s. cloth. Dr. Mantell.
Geometrical Mensuration, &c., Principles of, 12mo. 3s. 6d. T. Tate.
Geometrical Problems, 8vo. 3s. 6d. sewed. H. Latham.
Geometry, Analytical, 3d edition, 8vo. 10s. 6d. boards. J. Hymer.
Germany, her Romances, royal 8vo. 12s. cloth. J. M'Gregor.
Globe, Glance at the, foolscap 8vo. 4s. 6d. cloth. Taylor.
Gothic Ornaments, part 2, 4to. 10s. sewed. Collings.
Do. do. part 4, 4to. 10s. sewed. Collings.
Great Comet, Return of the, 8vo. 2s. 6d. sewed. J. R. Hind.

Light and Shadow, Hints on Composition, new edition, 21s. cloth. T. Prout.
Locomotive Engine, 2d edition, 12mo. 4s. cloth. Templeton.
Locomotive and Telegraph, foolscap 8vo. 2s. 6d. cloth.

Magazine of Science, &c. vol. x. royal 8vo. 8s. cloth.
Marine Botanist, coloured Plates, 12mo. 5s. 8d. cloth. J. Giffords.
Mathematics, First Course of, 8vo. 10s. 6d. boards. J. Hattersley.
Mechanical Philosophy, Encyclopædia of, 4to. 42s. cloth. Barlow and Herschel.
Military Sciences, Aide Mémoire, part 1, vol. ii. 8vo. 16s. boards.

National Encyclopædia, vol. iv. 8vo. 5s. cloth.
Natural Philosophy, Elements of, 3d edition, foolscap, 12s. 6d. cloth. Dr. Bird.
Natural Philosophy, 2d edition, 18mo. 4s. 6d. cloth. W. Martin.
Nautical Magazine, 1847, 8vo. 13s. 6d. boards.
Navigation, Epitome of, 14th edition, 8vo. 16s. boards. J. W. Norie.
Neptune, the Planet, its History, &c. Plates, 8vo. 5s. 6d. J. P. Nichol.

Painting, Lectures on, crown 8vo. 7s. 6d. H. Howard.
Philosophy of the Beautiful, foolscap 8vo. 5s. cloth. Cousins.
Philosophical Tendencies of the Age, 8vo. 5s. 6d. J. D. Morell.
Physical Atlas, folio, £10 10s. half-morocco.
Plane and Spherical Trigonometry, part 1, 12mo. 5s. H. W. Jeans.
Planter's Guide, 3d edition, 8vo. 21s. cloth. Sir H. Stuart.
Polarized Light, on the Study of, 8vo. 3s. cloth. Woodward.
Port and Docks of Birkenhead, Maps, &c. 8vo. 15s. cloth. J. Webster.
Practical Mechanics, Mathematics for, 3d edition, 8vo. 21s. half-bound. O. Gregory.
Practical Arithmetic for Adults, 12mo. 2s. cloth. S. Fletcher.

Railway Acts, Abstract of the Special, 1847, 12mo. 14s. cloth.
Railways and Commerce, Facts relating to, 2s. 6d. cloth. Salt.
Railway Engineering, or Field-work, 8vo. 5s. cloth. T. Baker.
Railway, London and North Western, History of, 10s. 6d. T. Roscoe.
Railway Map of Great Britain and Ireland, square, 2s. 6d. Weale.
Railways, Renting and Rating on, 8vo. 1s. sewed. L. Cooke.
Royal Society, History of, 2 vols. demy 8vo. 42s. royal 4to. 73s. 6d. Weld.

Scriptures and Geological Science. on the, 8vo. 9s. cloth. J. P. Smith.
Shipbuilding, Theory and Practice of, 8vo. 16s. cloth. J. White.
Ship, History of a, from her Cradle to her Grave, 16mo. 4s. 6d. cloth.
Skerryvore Lighthouse, royal 4to. £3 3s. cloth. A. Stevenson.
South Australia, its Resources, &c. 10s. G. B. Wilkinson.
Steam Engine, High Pressure, translated by W. Pole, 10s. 6d. Dr. Ernst Alban.
Steam Warfare in the Parana, 2 vols. post 8vo. 21s. cloth. Mackinnon.
Stellar Universe, its Arrangements, &c. 5s. 6d. cloth. J. P. Nichol.
Sugar Cultivation, by a European, &c. Manufacturer, part i. 8vo. 4s.
Sugar Planter, Practical, 8vo. 21s. cloth. S. Wray.

Tradesman's Book of Ornamental Design, 4to. 21s. J. Ballantine.
Trigonometry, Elements of, 7th edition, 8vo. 10s. 6d. boards. J. C. Snowhall.

Useful Knowledge, Library of Mathematics, 2 vols. 8vo. 2s. sewed.

Volcanoes, Earthquakes, &c. Description of, 8vo. 21s. C. Daubeny.

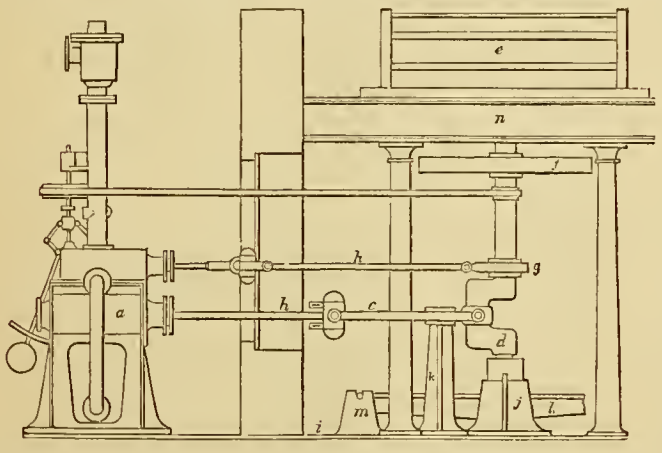
Water Colours, Drawing and Painting in, 3d edition, 8s. 6d. J. Clark.
Water Colour Painting, a Treatise on, Plates, imperial, 21s. cloth. T. Miller.
World, External Nature and Elements of the, 8vo. 10s. cloth.
World, System of the, 2d edition, post 8vo. 10s. 6d. J. P. Nichol.

RECENT PATENT.

HASTIE'S METHOD OF DRIVING CORN MILLS.

The object of this invention is to simplify the application of steam power to turn certain mills or machines, by making the axis of the crank of the steam-engine serve also for the axis of the mill or machine, which axis may be either vertical or horizontal, according to the construction of the mill or machine; for instance, in corn mills the axes are vertical, but in paper machines they are horizontal.

The accompanying illustration exhibits the application of steam power to turn one pair of mill-stones according to this invention. *a*, is the steam cylinder, and *b*, the piston-rod, connected by a pair of connecting rods, *c*, with the crank-shaft, *d*, which forms the axis of the upper mill-stone, *e*. The joints that unite the ends of the rods, *c*, with the piston-rod and crank-shaft are universal. The shaft, *d*, is provided with a fly-wheel, *f*, which serves to receive an endless belt for driving flour-dressing machines; and there is also an eccentric, *g*, on the shaft, *d*, for communicating motion



by the rod, *h*, to the slide-valve belonging to the steam cylinder, *a*. The cylinder, *a*, is supported upon legs, bolted to the bed-plate, *i*; and from this plate rises a small standard, *j*, which carries the bearing for the lower end of the shaft, *d*, and likewise a standard, *k*, which sustains a guide for the end of the piston-rod. The lower end of the shaft, *d*, is not supported longitudinally by the bearing in the standard, *j*, but only laterally; and there is a hardened steel pivot in that lower end, which rests upon a similar plate lodged at the bottom of the cell formed in a bearing lever, *l*. This lever is sustained at one end by a centre pin or fulcrum in a low standard, *m*, and the other end of the lever is suspended from the frame, *n*, by a long screw-bolt, which, being turned, or a nut fitted upon the screw thereof being turned, when required, will raise or lower that end of the lever, and thus the upper mill-stone can be accurately set to the intended distance from the lower one. It is on account of the vertical movement which is occasionally required to be given to the shaft, *d*, that the connecting rods, *c*, are united to that shaft and to the piston-rod by universal joints.

When two pairs of mill-stones are required to be worked by the same engine, this may be effected by causing the piston-rod to pass through both ends of the cylinder, *a*, and connecting it at each end with the shaft, *d*, of the upper mill-stone belonging to the pair of mill-stones, which are on that side of the steam-engine; and in case it should be desired at any time to work only one of the upper stones, the other may be disconnected by detaching the connecting rods belonging thereto.

The improved mode of applying steam power to turn a mill-stone may be used in windmills or watermills, in order to work the same when there is a failure of wind or water. In such case (everything being arranged as in the drawing) the shaft, *d*, may have upon it the ordinary spur-pinion, by which the upright axis of a mill-stone is turned in wind and water-mills, such pinion being fitted on the shaft, *d*, in a suitable manner, to admit of its being moved into and out of gear with the large spur-wheel of the wind or watermill, by which it is to be driven when wind or water can be obtained.

Another mode of applying steam power to turn two, three, or more mill-stones, by one steam cylinder and piston, is described by the patentee; in which the shaft, *d*, instead of being the upright axis of a mill-stone, is a distinct upright axis furnished with a toothed wheel, to give motion to two, three, or more pinions, upon the upright axis of a corresponding number of mill-stones, arranged around the said toothed wheel.

Although it is stated that the connecting rods are jointed to the crank-shaft at one end, and to the piston-rod at the other, such connecting rods may be dispensed with, and the end of the piston-rod jointed to the crank, if the cylinder is suspended, so as to be at liberty to vibrate or oscillate on trunnions, projecting from each side of the cylinder.

The patentee concludes by stating, that his invention "consists in the simplified mode, hereinbefore described, of applying steam power to turn corn mills, bark mills, and other mills, which operate by the continuous rotatory motion of vertical axes; also grinding mills, with grindstones, paper, and other mills, which operate by continuous rotatory motion of horizontal axes, the said simplified application being, in either case, performed by a direct action of the piston-rods and connecting rods, or of the piston-rods of the steam cylinders of steam-engines upon the pins of cranks, formed or fastened upon the said vertical or horizontal axes of the mills or machines, with suitable fly-wheels and eccentrics on those axes; and which axes, at the same time that they form part of the mill or machine, according to the usual construction thereof, also answer the purpose of the revolving axes of the cranks, and fly-wheels and eccentrics; which axes, according to the usual construction of steam-engines, form part of the steam-engines by which the mills or machines are turned; but according to the patentee's mode, the same revolving axis may be considered as forming part of the steam-engine, and also as forming part of the mill or machine, because it is made to serve the purpose of both."

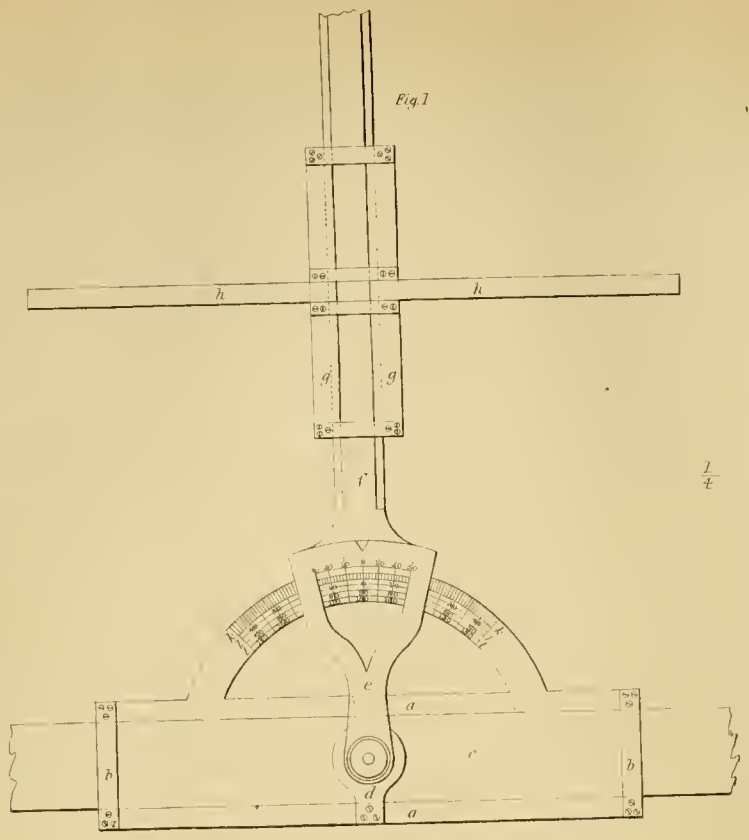
This arrangement has been put in practice at the Cartsdyke mills, near Greenock, where four pairs of stones are in operation, and we understand that several of a similar construction are being made for Australia and the colonies. The plan presents some facilities for varying the productive power of the mill, unattainable in mills driven by the ordinary system of gearing, as any single pair of stones may be put in operation at a few minutes' notice. Unlike the usual arrangement for giving motion to grinding machinery, any number less than the whole complement of stones may be driven with the same proportionate expenditure of power, as each pair being totally independent of its neighbour, its working does not interfere with the gearing of the remainder of the series, and consequently the wear and tear and expense of driving a long range of shafting, which must be generally incurred in driving only a single pair of stones, as ordinarily arranged, is saved. As far as regards the plan of turning "two, three, or more mill-stones by one steam cylinder and piston," Mr. Hastie has been forestalled by Dr. Ernst Alban, who has given an engraving and full explanation of a similar arrangement in Parts III. and IV. of his work on the high-pressure steam-engine, just issued from the press. Dr. Alban's cylinder is bolted to a cross piece on a vertical axis, which is supported in a top collar and footstep, so as to admit of oscillation horizontally; the piston-rod being jointed directly to a pin on the upper side of the main driving spur-wheel.*

The idea of making the steam-engine crank-shaft serve also as the spindle of the mill-stones, brings us back to the days of the Romans, who employed *querns* or hand-mills, not unlike the one before us in its propelling arrangement; and the Spaniards of the present day, have a similar mill for grinding pease and beans for cattle. It is nevertheless a highly elegant plan, and greatly simplifies the working parts of the mill. A question may be raised as to the expense of the fitting up each pair of stones, with a separate steam-engine; on this head we possess no positive information, and consequently cannot state the exact proportion of cost.

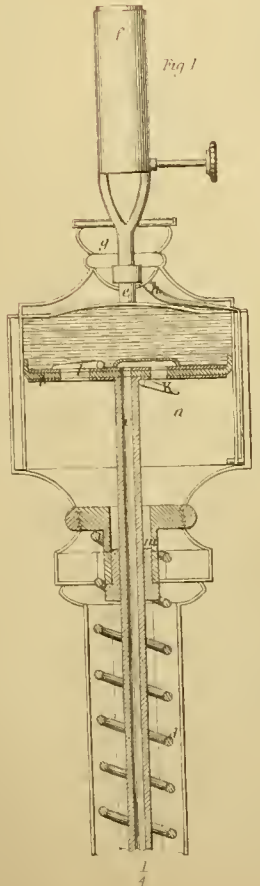
Specification enrolled, January, 1848.

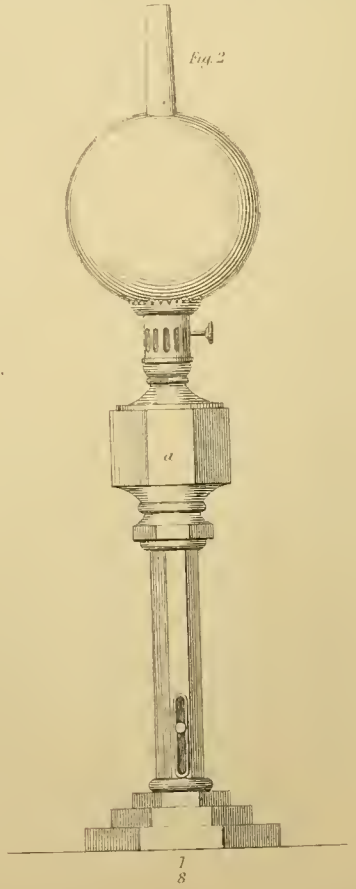
* See our "Reviews of New Books."

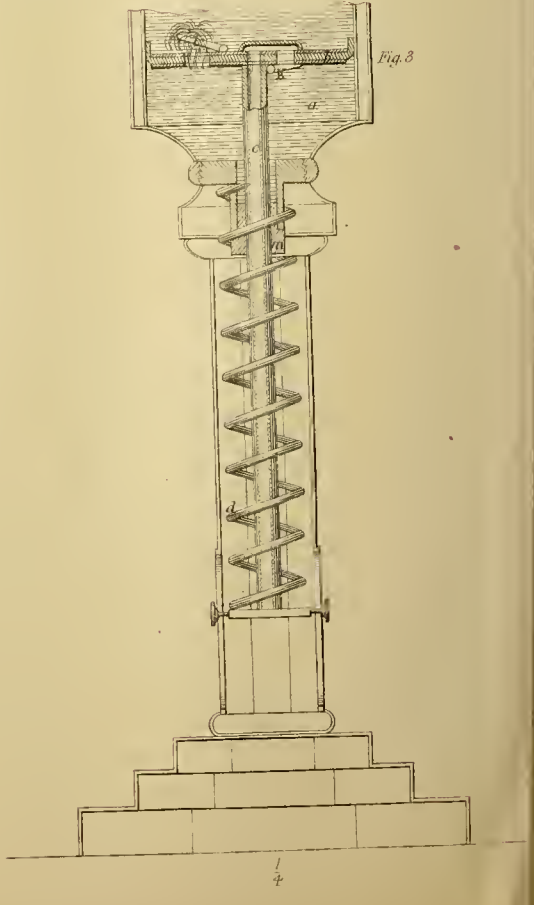
SIMPSON'S DUPLEX STRAIGHT-EDGE PROTRACTOR.



ROBERTSON'S EQUILIBRIUM LAMP.







W. Johnston
Lithy. Office Glasgow

REGISTERED DESIGNS.

DUPLEX STRAIGHT-EDGE PROTRACTOR.

Registered for GEORGE SIMPSON, Esq., *Mining Engineer*, 3 *West Nile Street, Glasgow.*

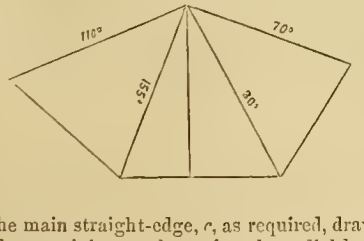
Illustrated by Plate 9.

Fig. 1 of the drawings on this plate represents a quarter size plan view of the Protractor; fig. 2 is a longitudinal section. The graduated quadrant, forming the index for the angles, is in one piece with a parallel bar, *a*, which is connected at each extremity by means of transverse bars, *b b*, with a similar bar, *a*, the space between the two being of such a width as to admit the straight-edge, *c*. A central transverse piece, *d*, which is screwed to the two bars, *a a*, carries a pivot or joint-stud for the eye of a radial straight-edge, *e f*, having its edges bevelled off for ruling close to the paper.

On this radius bar are fitted two parallel bars, *g g*, each in one piece with the straight-edges, *h h*, being braced together by cross pieces, so that the whole may slide loosely upon the radius bar. At a short distance from the centre of motion of the radius bar, *e f*, is a segmental opening, graduated to 30° on each side of the centre, or zero point, forming two verniers for instruments differently divided, and for the minute subdivision of the gradnations upon the quadrant on the piece, *a*. By this apparatus, any angles may be measured and laid off by the quadrant, and transferred to any point on the paper without the aid of any additional instrument, as the whole instrument may be moved to any desired point on the straight-edge, *c*, without any shift of position with reference to the meridian line, or starting point. With additional scales on the right-angle straight-edges, *h h*, the instrument may be applied as an offset scale for plotting surveys, and laying down sections. The whole of the parts are registered as new, for the purposes before described.

Engineers who are in the habit of using the ordinary protractor to any considerable extent, will at once see the superiority of action, and economy of time, gained by Mr. Simpson's instrument. The most approved protractor now in general use, consists of a circular bar divided to 360°, and having two diametrical arms, one of which carries a vernier adapted to the divided circle. In laying off angles, or in the construction of any general delineations by this instrument, the bearings must first be marked on the original sheet, and thence transferred to the required position by parallel rulers, or some similar adjunct. Thus two separate instruments are necessary, and the accuracy of the indications suffers correspondingly. The duplex instrument being complete in itself, offers a greater degree of accuracy, and saves time in laying off.

For the benefit of the younger members of the profession, we may add the following illustrative account of its application in practice:—In laying down a survey, the main straight-edge, *c*, and quadrant must be so set as not to interfere with the line of surface for the survey, and in such a position, that one side of the straight-edge, *e f*, shall coincide with the meridian line on the paper, when the vernier is set to the zero point. The main straight-edge is then to be fixed to the drawing surface by two pins at each end, when the angles indicated by the divisions, *k k*, may be laid off by the radial straight-edge, *e f*, and the angles, *l l*, by the right-angle bars, *h h*. Let us suppose that it is required to lay off the annexed figure of a variety of angles. The straight-edge, *e f*, being set to coincide with the meridian line, M, the vernier is to be set to 110°, and the cross bars passed along the radial arm, *e f*, to the point, M, and by it the line, M N, may be drawn. Next, set the vernier to 50°, and from the point, N, after the quadrant has been shifted on the main straight-edge, *c*, as required, draw the line, N O; and so on with the remaining angles, using the radial bar, *e f*, or the right-angle bars, *h h*, accordingly as the lines to be drawn form acute or obtuse angles with the meridian line. We have ourselves, on different occasions, made use of one of Mr. Simpson's instruments; and a complete one may be seen at the Model Room of our office.



EQUILIBRIUM LAMP.

Registered for HUGH ROBERTSON, Esq., *Jun. of Gartloch.*

Illustrated by Plate 9.

The lower portion of Plate 9 contains three views of this lamp. Fig. 1 is a vertical section through the oil reservoir and portion of the column, the globe and chimney being removed; fig. 2 is a complete external elevation; and fig. 3 is a vertical section, with the burner and upper portion of the oil reservoir removed, showing the actuating spring and piston-rod in elevation. *a*, is a cylindrical reservoir for containing the oil or other liquid employed in the production of light; it is surrounded by an outer octangular casing, as seen at *a*, in the elevation, fig. 2. This cylinder is fitted with a piston, *b*, for the support and supply of oil to the burner. The piston is formed of two discs of sheet metal, between which is fitted a piece of leather turned up on its circumference, so as to bear upon the interior of the cylinder, *a*, and is attached to a vertical rod, *c*, passing down the centre of the hollow-supporting column of the lamp. At the lower end of the piston-rod is attached a disc, or cross piece of metal, to which the lower extremity of a helical spring, *d*, is attached, the upper end being fastened to the bottom of the oil cylinder, *a*. The disc at the foot of the piston-rod, *d*, is fitted with two stud buttons projecting through slots cut in the sides of the column; when the piston is drawn down in the cylinder by these studs, the reactive tension of the spring, *d*, will tend to force up the piston, *b*, in the cylinder, and thus raise the oil above the piston, forcing a column up through the tube *e*, leading to the burner, *f*, at which height the spring is set to retain it.

To supply the lamp with oil, the globe and support resting on the cup, *g*, are removed, and the oil is poured into the cup, whence it is conveyed by the tube, *h*, which passes between the exterior of the oil cylinder, *a*, and the interior of the octagonal case, to the lower end of the cylinder beneath the piston—the air escaping from below the piston by the valve, *k*, thence through a covered passage on the top of the piston through the piston-rod, which is made tubular for the purpose. The valve, *k*, is provided with a float, so that, as the oil rises in the cylinder, the valve closes.

When the reservoir is full, the piston is drawn downwards by the stud buttons attached to the piston-rod disc, and the oil is thus forced through the valve, *l*, in the piston, opening upwards. When the piston is released, the spring immediately acts upon the piston, and, being made of such a strength as to balance the exact height of column of oil required to reach the burner at all periods of its action, a regular supply is thus kept up. The piston-rod is passed through the bottom of the oil reservoir by a stuffing-box formed of a ring of gutta percha, fitted into a short open chamber on the lower surface of the reservoir. This arrangement is the one represented in our plate, but the one contained in the registered sheet is composed of a membraneous or flexible oil-proof conical tube. The narrow end of the tube is fitted tightly on the piston-rod, immediately below the piston; its wider and lower end being attached to the mouth of the small chamber formed on the bottom of the reservoir. The piston-rod passes freely through this chamber, which forms a receptacle for the flexible material or membrane, when the piston is near the bottom of its stroke. The whole of the parts of the design are registered as new and original, as combined to form an equilibrium or self-regulating lamp.

A lamp of this construction has been in regular use for several months past, and we have had the opportunity of noting the extreme accuracy and regularity of its action, the oil being invariably retained at the exact level of the burner, so that there is never either a feeble supply or an overflow at that point. This result has been arrived at by continued experiments, showing that a spring may be so arranged as to act as a compensating pressure for the ever-varying height of the oil column; that the collapsing and consequent loss of power of the spring, as the piston moves upwards, may be accurately proportioned to the decrease of the height of the column. When the oil cylinder is empty, the spring sustains no greater pressure than that resulting from the weight of the piston and rod alone; and when full, that pressure is increased by the weight of the oil. The problem then was, how to make provision for the constant height of the column. If we suppose the weight of the oil to be 1½ lbs., and the traverse of the piston to be 2½ inches, the lamp will require an actuating spring which shall lose 1½ lbs. of pressure in collapsing to an extent of 2½ inches. A spring answering to these conditions may be obtained in a simple manner, merely by testing a helix of various lengths, gradually shortening its coils, until the desired tension is gained.

The column of oil may either be kept at the exact level of the wick, or, as in the Carcel lamp, a slight overflow may be allowed for in the strength of the spring. The former arrangement is the most advantageous in two respects—namely, that the lamp will continue to burn longer without a fresh supply; and that the level of the oil in the burner being subjected to a stronger heat previous to its consumption, is necessarily rendered more fit for combustion, as the heated portion is not carried away by the overflow. The equilibrium lamp has been repeatedly compared with the Carcel, for the purpose of deciding as to the relative value of the two arrangements, and the difference in the intensity of the light is considerable.

REVIEWS OF NEW BOOKS.

THE HIGH-PRESSURE STEAM-ENGINE: an Exposition of its Comparative Merits, and an Essay towards an Improved System of Construction. By Dr. Ernst Alban, Practical Machine-Maker, Plau, Saxony. Translated by W. Pole, C. E. Parts 3 and 4, 8vo. Pp. 145. Plates. London: Weale, 1848.

Dr. Alhan's opinions on the theory of the high-pressure steam-engine, and his practical ideas on boilers, have already been laid before the public in Parts 1 and 2 of this work,* and now, after a lengthened interval, he meets us again with a more tangible point in view—the practical exemplification of his precepts. The book is throughout a novelty not often met with, its object being the upholding of the superiority of the high-pressure as compared with the low-pressure engine. As a practical man of thirty years' standing, the author's views are deserving of the deepest consideration, were it not that we have reason for presuming that, in his zealous study of the high-pressure engine, he has overlooked some of the favourable features of the opposite class.

Parts 1 and 2, conjoined, are devoted to the consideration of the high-pressure engine in its general features; an examination of the principal objections brought against it, more particularly its danger; and an enumeration of the peculiar advantages which it possesses, more especially its simplicity, compactness, cheapness, lightness, and convenience in working, treating these features with considerable clearness and accuracy of detail. He then proceeds to treat of the boiler, discussing it in detail, and describing two kinds which he employs for his high-pressure purposes. Parts 3 and 4, now before us, are more fully devoted to the consideration of the practical details of the engine, giving a preference to the oscillating species; and with remarks upon the economy of the system, the dimensions and proportions of the engines, their application to machinery of various kinds, and the use of the waste steam.

The commencement of this volume is taken up with a continuation of the author's dissertation on boilers, where he says:—

"For a period of now twenty-five years, I have been occupied with the attempt to contrive a boiler having the tubes placed in several rows over each other, in such a manner that those of each row should lie over the interstices of the row immediately beneath, and that the heated current should be compelled to pass in zig-zag between them, in thin streams, every moment changing its course, and striking as nearly as possible perpendicularly against the under surfaces of the tubes. I clearly perceived, that when the heat was made to act thus upon a suitable number of rows of tubes, it must be more perfectly applied than when, as in the before-described boiler, the current passed parallel to the heating vessels in a thick stream and with a quick draft. For a long time I could not succeed in carrying out my plan, since, in spite of all my endeavours, I could discover no satisfactory method of connecting such a large number of tubes with each other and with the necessary receivers, in order that the steam might be led away without interfering with the proper water-feed, and also might be so perfectly separated from the water as to leave no danger of priming in the engine, even with the small separating vessels. At length, however, after laying the subject aside for a time,† the solution of the problem occurred to me. A small model, which I constructed of tin plate,‡ gave the most surprising results, and proved that this boiler, even with low pressure, not only removed the danger of the tubes boiling dry, but was also free from the great defect of all tubular boilers, particularly the more modern ones, namely, the danger of water passing over with the steam into the engine."

Inventors generally will agree with the author as to the development of happy ideas; few who have essayed the invention of anything of moment will hesitate to sympathise with him. The boiler which he conceives to answer his requirements is of a rectangular form, having copper tubes of 4 inches diameter, and one line in thickness; and, as he observes, "in order to give the vapour a tendency to stream towards its exit opening, the tubes are laid a little on the incline, the back end being, in a length of 4 feet, about ½ or ¾ inch lower than the front end." The furnace bars extend along the whole length of the tubes, and the flame plays through the interstices formed by their exterior surface, the tubes themselves being in connection with the back plate of what the author terms the "heart," or chamber, used for the two purposes of carrying off the steam and supplying the tubes with water. Each tube communicates with this chamber by two oval openings bored through the inner plate of the latter, the upper one being for the exit of the steam, and the lower one for the admission of the feed-water. The heart, so termed from its use in promoting a due current in the boiler, is a flat chamber, from 6 to 8 inches deep and 40 inches high. Above the rows of tubes, two tubes of larger diameter are set in the brickwork of the top of the flue, and are acted upon by the flame and heated air passing up between the tubes. These upper tubes are respectively termed the separator and receiver. The pipe conveying the steam from the upper end of the heart enters at the front end of the separator, the steam and water being carried off from the back of the receiver; the steam, by a short connecting pipe, passing from one tube to the other, and the water, by an end tube, forming a communication between the two water spaces. The action of this boiler, as explained by the author, is as follows:—The steam collected in the upper part of the water tubes, immediately over the fire, finds its way, through the openings, into the heart, passing into a canal upon the top of the latter chamber, and thence into the separator, when the arrangement of the receiver and its pipes admits of a clear separation of dry steam from the water carried up by the current, the water being returned to the heart, where it again enters the tubes.—The work has been received too late in the month to permit of our entering further into it. Next month we shall discuss it more fully.

* See our notices of it in Vol. II., N. S., Practical Mechanic's Magazine.

† "It has been my custom, when I have long brooded over a subject in vain, to lay it by, upon principle, for some time; for I have always found that happy ideas are by no means to be squeezed out of the brain, but rather are dependent on fortunate moments, which, the more sought, appear the farther removed. The most interesting matters are, after all, generally stumbled on. The inventive spirit of man, however active, clear, and powerful, relaxes under the force it is subjected to—becomes partial, confused, and heavy, under the continual pursuit of one object; operates perversely, or loses itself in things of secondary importance. Allow it a charitable interval of rest, lead it for a time upon a new and different field, and it collects itself new power to shed light upon the path over which it had before so darkly stumbled."

‡ "I have always made the models of boilers on which I was experimenting of this metal, for the reason that I could then discover if any parts were subject to boiling dry, by a very simple indication, namely, that in these parts the solder melted, causing leaks, which were immediately detected."

ON A UNIFORM SYSTEM OF SCREW THREADS. By Joseph Whitworth, Esq., Mem. Inst. C. E. Pp. 16. Woodcuts.

This is a re-issue of an excellent pamphlet, originally published from the records of the Institution of Civil Engineers, where it found a place in 1841. Since this date, the author's suggestions have been largely acted upon by the majority of the profession, and thus the great perplexity consequent upon an indefinite choice of proportions in screws of every kind has been in a very great measure obviated. Much yet remains to be done in completely removing the evil, and the importance of the subject must be our excuse for again bringing it before the consideration of those who have so far lent no helping hand in the cause. So long as the same screwing tools are made use of for repairs and alterations in the same works, no material difficulty arises; but when machinery manufactured in one establishment comes to be repaired in another, perhaps very distant one, the want of correspondence of the two systems of threads is most severely felt. Besides the irregularity and loss of time involved in this arbitrary system of threads, the matter assumes a very serious aspect when viewed as a direct addition to the expenses of machinery. As an example, a large railway establishment is supplied with locomotives and tools from half-a-dozen makers, all of whom use their own distinct arrangements of screwing tackle, so that it becomes essentially necessary that each maker should supply, along with the machine he makes, a complete set of the screwing apparatus employed in its construction.

In settling upon a fixed scale of proportion of threads, Mr. Whitworth made an extensive collection of screw-bolts from the principal English workshops; and taking the average of the proportions thus obtained, he fixed upon it as a datum whence to draw up a regular scale of pitches.

In conclusion, we quote the author's own observations on the maintenance of uniformity:—

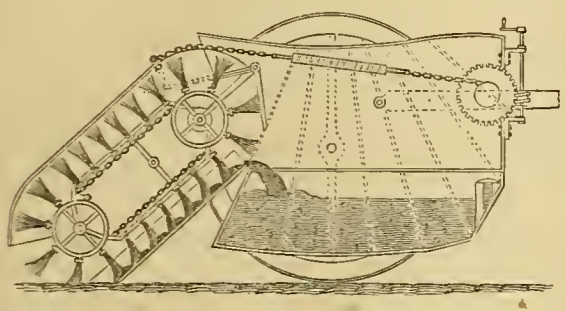
"To maintain uniformity, provision must be made for multiplying standards of diameters and threads. Without a particular provision of this kind, which, as will be shown hereafter, may be easily made, the screwing tackle would degenerate by use and propagation. This part of the case is connected with a subject of great extent, which, under every aspect, lays claim to the attention of practical engineers. We allude to the general use of standard gauges graduated to a fixed scale, as constant measures of size. It is quite practicable by such means to work to a common measure with a degree of accuracy sufficient for all ordinary purposes. Corresponding parts, instead of being got up one to another, might be prepared separately. The indefinite multiplication of sizes would thus be prevented, and the economy of the workshop simplified to an extent beyond calculation."

ON THE ADVANTAGES AND ECONOMY OF MAINTAINING A HIGH DEGREE OF CLEANLINESS IN ROADS AND STREETS; with an Account of the Construction and Operation of the Street-Sweeping Machine. By Joseph Whitworth, Esq., Mem. Inst. C. E. London, 1847. Pp. 36. Woodcuts.

We have here another of Mr. Whitworth's productions, which the Institution of Civil Engineers may be said to have called into existence. The subject of which it treats was never more deserving of consideration than at this moment, when the increasing tendency to disease in large towns, consequent upon a want of cleanliness, is becoming so serious a matter. There are few bad habits more easily acquired by the operative population than that of filthiness, and no single point connected with the domestic arrangements of cities impresses a country visitant so strongly as the obtuseness displayed by the inhabitants of crowded quarters with regard to the ordinary rules of cleanliness. The details of manufacturing cities are in many ways inimical to cleanly habits; the dwellings

are closely packed, receptacles for noisome products are often far distant, and the once-orderly country artizan often settles down in a dismal alley, where he soon loses his original standard of comfort in the midst of his poisonous and over-populated neighbourhood. Without a remedial agent for this evil, the system of street-sweeping advocated and practised by Mr. Whitworth would be of little avail, as it is only the main thoroughfares which can be cleansed by its means; but with an ample supply of water, perfect drainage, and a proper disposition of all decomposing matter, its advantages are obvious as compared with the common system of hand-sweeping.

The pamphlet before us represents, in a series of well-executed woodcuts, the relative workings of the two; and as an assistant to the comprehension of the action of the machine, we have transferred one of them to our pages. The apparatus consists of a series of broad brooms, about 2 feet 6 inches wide, attached to two endless chains, running over an upper and lower set of pulleys, which are suspended in a light frame of wood behind the body of the cart. Each of the cart-wheels is fitted with an internal toothed ring, bolted to the inner side of its periphery, and gearing with pinions on the shafts of the pulleys carrying the endless chains and the series of brooms attached thereto, which, being made to bear on the ground, successively sweep the surface, and carry the soil up an incline or carrier plate, over the top of which it is dropped into the cart.



The oblong form in which the brooms are arranged, is a peculiarity in the construction of the machine that is deserving of particular notice, as on it depends, in a great degree, the efficiency of its working. One advantage of this arrangement is, that the outer circumference of the brooms acquires a greater velocity whilst passing round the pulleys, being further from the centre than the chain which carries them. This extra velocity of the beard of the broom, in passing over the lower pulleys, is favourable to the operation of sweeping: and the soil being swept from the surface of the road on to the carrier-plate, is then carried, by the brooms, up the incline at a reduced velocity, thus saving the extra force and friction which would have been caused by a continued circular movement. Again, as the brooms pass over the upper pulleys, the increased velocity of their outer circumference, and the sudden change of direction they acquire, act most opportunely in cleansing them, as they revolve, against a bar called the "doctor." If the horse travels at the rate of three miles an hour, the velocity of the brooms on the ground is nine miles; but the soil is carried up the incline at the rate of three miles only, and the brooms are cleansed against the doctor at the rate of six miles per hour. These advantages are peculiar to the oblong arrangement of the brooms. A circular arrangement of the brooms, besides giving great increase of friction, would cause the soil to fly off in all directions, and a great part of it would be continually carried round.

The pressure of the brooms on the surface over which they are passing is regulated with ease and nicety, by means of a coiled spring and chain, connected to a pulley, which is regulated by a handle, in the front of the cart. The spring is so adjusted as to relieve the pressure of the brooms on the ground, at the same time allowing the apparatus to rise and fall, according to the inequalities of the pavement. The same handle which regulates the pressure will, when necessary, raise the brooms and the frame together, so as to suspend the operation of sweeping, as when the machine is full, or the surface not fit for cleansing, or when unloading.

By giving a slight obliquity to the afterpart of the machine, it is enabled to sweep close up to the curbstone along the side of the street.

The power required during the process of filling, is rather greater than would be necessary to draw the loaded cart an equal distance. The machine is constructed for a strong horse, which must be well fed to keep it in condition.

The surface daily swept in Manchester, by each machine with one man and one horse, varies from 3 to 4½ statute acres; and the quantity removed is from one to three loads per acre, according as the surface is dry or wet.

The cause of the economy of street-cleansing by aid of the machine, as compared with the system of hand-labour, will appear, when it is considered that the latter consists chiefly in sweeping the dirt from one part of the surface to another, and collecting it into heaps, which must afterwards be loaded into the carts. Whereas, in machine-cleansing, the whole of these tedious operations are superseded, and the sweeping, gathering, and loading are performed at the same time. In hand-sweeping, the dirt is moved over a surface of 20 or 30 feet, whilst it is being gathered into heaps for removal, and afterwards it has to be lifted some 5 or 6 feet into the carts by manual force; in the combined operation of sweeping and loading by the machine, the dirt is moved the length of the inclined plane, or carrier-plate, only, or a distance of about 3 feet. Thus, in machine-sweeping, not only is horse labour substituted for human labour, but the process itself is shortened and force economized. It was the consideration of the evident waste of power in the common method of cleansing, from the necessity for dirt being moved so far, before arriving at its destination in the cart, that led to the invention of the machine.

The author observes that the cost of working each machine is from 10s. to 15s. a day; and for this outlay, from 14,000 to 20,000 square yards of surface is swept. From these data, any one may calculate the relative values of the hand and machine systems. We have remarked on numerous occasions, in Manchester, Preston, and other towns, the complete efficiency of the machines in making a clean smooth surface, and possibly our own streets would not suffer by a test of their powers.

Report of the Directors of the Glasgow Athenæum.

April, 1848.

The first Annual General Meeting of this Society was held on the 11th of April last, in the City Hall. Although originated at a period of almost unparalleled depression of trade, the vigorous exertions of the directing heads of the Institution have been attended with the most complete success in the carrying out of their well directed designs. At the date we write, the number of members and subscribers is 14 life, 1867 annual, and 138 quarterly: in all, 2133—with a balance of cash in hand of £847. The News and General Reading Rooms are now on the most extensive scale, and furnish a large amount of information on terms most moderate. In the News Room, 500 copies of the leading journals are supplied weekly; and during the late exciting events on the Continent, additional opportunities of obtaining information were supplied for the benefit of the members. The Reading or Magazine Room is furnished with 14 weekly, 71 monthly, and 15 quarterly publications. The Library, which owes its existence to the liberality of the different supporters of the Institution, contains nearly 2,000 volumes: it was opened on the 1st of June, for general circulation.

"The following Lectures have been delivered since the commencement of the Session:—Three Lectures, by Professor J. P. Nichol, 'On Recent Discoveries in Astronomy.' Five Lectures, by Dr. Samuel Brown, of Edinburgh, 'On the Idea of Magnetism.' Six Lectures, by A. J. Scott, Esq., of London, 'On the Middle Ages.' Four Lectures, by J. D. Morrell, Esq., 'On the Philosophical Tendencies of the Present Age.' Two Lectures, by Ralph Waldo Emerson, Esq., one 'On the Characteristics of the six New England States,' and one 'On the Genius of the Present Age.' One Lecture, by the Rev. Dr. King, 'On Geology.' One Lecture, by the Rev. R. Jamieson, 'On the Leading Characteristics of Natural History.' Three Lectures, by George Dawson, Esq., 'On Switzerland.' One Lecture, by Dr. J. W. Hudson, 'On Domestic Life in Northern Germany.' The Lectures by Professor Nichol, Rev. Dr. King, Rev. R. Jamieson, and Dr. J. W. Hudson, were delivered gratuitously."

"An arrangement, by the kindness of James Lumsden, Esq., has been effected, by which Members of the Athenæum are admitted at half the usual charge to the Royal Botanic Gardens for the present year; and your Directors have reason to believe, that their application for the erection of a Gymnasium at the Gardens has been responded to by the proprietors. By an agreement entered into with the Glasgow and West of Scotland Horticultural Society, the Members of the Glasgow Athenæum are to be admitted to all the public exhibitions of this Society at half the charge made to the public, and to the private exibitions they are to be admitted free."

By the terms of the Scottish Union of Popular Literary and Mechanics' Institutions, the members of the Athenæum may now be admitted to every similar institution in Scotland, and to all the principal Literary and Mechanics' Institutions in England. We look upon this arrangement as one of the utmost importance for the promotion of the general well-being of this class of societies, and the fostering of that brotherly sociability amongst the members, so much to be desired. In congratulating the directors upon the success of their labours, we would urge upon them the essential necessity of an inviolable unity of action in all things tending to the development of the resources they have at their command. Undivided exertions, properly directed, may effect much that is good for the interest of that class who form the character of a city—its junior residents. Without this, their best attentions will be useless.

CORRESPONDENCE.

ON THE FORMATION OF COAL.

Your correspondent, Mr. Robertson, of Halbeath Colliery, in the April Number of the 'Practical Mechanic's Journal,' seems to think that, because he has never found the internal portion of fossil trees of the carboniferous formation converted into coal, the view which ascribes this mineral to a vegetable origin is not altogether without its difficulties. It is certainly correct, that in such fossils, generally, their original substance has been replaced by sandstone or shale, and nothing has been converted into coal except the thin cuticle; but cases are not wanting, in which the *internal portion* has undergone a similar conversion. The Newcastle Museum contains a log, as it were, of apparently coniferous fossil wood, for the most part changed into coal; and I have lately procured a specimen of *Stigmaria*, from the roof of one of our pits, having the whole of the large outer zone, consisting originally of cellular tissue, in the condition of pure cherry coal, but with its ligneo-vascular cylinder replaced by sedimentary matter. A case of this kind is exceedingly difficult to explain, inasmuch as the tissue of the ligneo-vascular cylinder, from its firmness, was more likely to be preserved, than the thin soft *parenchyma* composing the outer zone.* In fact, this is what generally obtains; for, in most of the coal-measure plants I have examined, containing internal structure, the ligneous and vascular tissues alone are preserved—the exceptions being *Lepidodendron*, and some undescribed ferns, whose cellular tissue appears to have been as hard as the woody fibre of many dicotyledons. But vegetable fossils of the carboniferous epoch, I may observe, are found in all states. Specimens of *Stigmaria* are not uncommon, in which the cellular tissue of the outer zone, pith, and medullary rays, is replaced by mechanically-deposited matter; while the part that was occupied by the fibrous bundles of the ligneo-vascular cylinder is vacant, forming an exact mould of this part. In many fossil woods, the vessels are filled with silex, carbonate of lime, &c., the walls of the vessels often being the only parts that have become bituminized. In such cases, these substances, in the state of solutions, have permeated the vessels after the disappearance of their albumen and other contents. In other fossil woods—as the *Stigmaria* and coniferous log already mentioned—nearly the whole of their substance has been changed into coal. Reverting to the first two cases I have mentioned, as they only bear on the point under consideration, I may observe, that if there are any "coal-pipes" associated with the coal beds Mr. Robertson is in the habit of examining, he may safely conclude that they are examples in which the original tissue of some plant has been converted into coal. The *Stigmaria*, before alluded to, is a portion of a coal-pipe.

Fossil plants, having their interior filled with shale or sandstone, do not in the least invalidate the view advocating the vegetable origin of coal; and the circumstance may be easily explained, on the idea that the tissues of such plants, in an early stage of fossillization, had decomposed or rotted out, leaving only the hard resisting cuticle to be converted into coal. Cases in which the like result would happen, under proper circumstances, are not uncommon at the present day. Mr. Hawkshaw mentions, that trees in this state abound in some of the forests of South America: trunks are lying on the ground, appearing as if formed of solid wood, but which are nothing more than hollow cylinders of bark—the wood having rotted out, through humidity and other causes. Suppose such hollow cylinders to be filled with sand or mud, they would closely resemble, in condition, most of the fossil plants imbedded in the coal measures. Perhaps, to obviate the difficulty suggested by Mr. Robertson, some one may hazard the opinion, that the stems of plants, such as *Sigillaria* and *Lepidodendron*, which are those generally filled with mineral matter, were originally hollow; but this is not the case, as proved by the researches of Brongniart, Lindley, Hutton, and others. Even *Calamites*, which many still suppose was fistular, and similar to *Equisetum*, was undoubtedly a hard, woody plant. Pitmen, in the course of their excavations, occasionally fall in with groups of fossil trees, standing erect, with roots shooting out in all directions, and as crowded as in a forest. Mr. Nicholas Wood, the eminent colliery engineer, some years ago, described in the 'Transactions of the Natural History Society of Northumberland,' &c. vol. i., a group of trees penetrating several strata at right angles: the roots and the lower portion of their stem, which were imbedded in shale, consisted of the same kind of sandstone as composed the strata enclosing the upper portion of the stem. The *Lepidodendrons*, mentioned by Mr. Robertson, form another case in point. Six years ago, I succeeded in erecting, in the Newcastle Museum, two beautiful specimens of *Sigillaria*, composed of shale, and encircled with a film of coal, originally the cuticle: both specimens are about 7½ ft. in height, and 27 in. in diameter, and were found standing erect, and rooted on a thin bed of coal. Such cases may be explained on the supposition, that the interior of the trees had rotted out while they were still standing in their original position, submerged in water loaded with mechanically-suspended matter—this matter, at the same time, gradually depositing itself in the hollow trunks, &c., and afterwards hardening so as to form the solid, erect, pillar-like fossils that have been mentioned. This view more particularly applies to the fossil trees found in a perpendicular position: those occurring in an inclined or a horizontal position appear not to have been so readily filled up with sediment, as the opposite portions of their cylinder of cuticle are generally found pressed together,—in many cases completely so,—in others, with only a thin layer of shale or freestone intervening. In many of the Newcastle pits, the roof, in some places, is crowded with fossils in this compressed state: trunks, roots, branches, and leaves are matted together, and entangled in the greatest intricacy; so much so, that the roof appears to be kept up by means of this complex interlacing. In some wastes, I have been compelled to creep through openings, formed amidst broken stems and roots, which appear to have been heaped together in the veriest confusion.

Coal beds have, undoubtedly, resulted from vegetable matter, which has been covered up with sand or clay shortly after its deposition; for it is difficult to conceive, on chemical principles, how it could have been converted into coal, had it remained for any length of time uncovered. The fossil trees, composed of sandstone, &c., must have been deprived of their tissues, through being exposed to the action of air or water; while those possessing organic structure, (leaving out of view the siliceous and calcified specimens,) as well as the vegetable masses, that have formed our coal beds, have been covered up and protected from these agents, and afterwards gradually bituminized by means of a peculiar kind of chemical action, which, I regret, neither time nor space will permit me to explain at present.

We are still very much in need of data respecting the kinds of plants whose remains have formed our coal beds: we can only be certain on this point by examining microscopic sections of coal. The late and estimable Mr. Witham discovered traces of coniferous wood in coal; and I have sections of this mineral from Hetton and Dalkeith, exhibiting numerous and decided traces of both cellular and fibrous tissue. It is highly probable, that coal beds are made up of the remains of most of the plants which grew not far from the places where they are now entombed. It will thus be seen that I am inclined to favour the view, that our coal beds are composed principally of drifted vegetable remains. I am led to this opinion, in consequence of only being certain that a few plants, such as *Sigillaria* (of which *Stigmaria* appears to have been the root), *Calamites*, and an undescribed bulbous plant, vegetated on the site of our coal beds. Mr. Robertson mentions a circumstance which may throw some light on the habitat of another plant, viz., *Lepidodendron*, specimens of which occur in the very heart of one of the coal beds of (?) Halbeath Colliery, having their inside filled with the same sandstone that forms the roof of the coal. Perhaps Mr. Robertson will favour the readers of the 'Practical Mechanic's Journal' with an account of the position in which these *Lepidodendrons* usually occur? If they are perpendicular, and have roots running out horizontally, I should be disposed to conclude that they grew in their present situation: we must not forget, however, that the 'snags,' so common in the American rivers, show that trees may be covered up in a growing position far from where they vegetated. From certain peculiarities in the roots of *Sigillaria* and *Calamites*, when found in their place of growth, and some other circumstances, I am led to conclude, that many coal beds of this district were formed in muddy swamps: and from the nature of the animal remains associated with deposits of this kind, it is evident that these swamps were subject, as circumstances most favoured, to the irruption of both marine and fresh water. The coal beds of the inferior division of the North of England carboniferous formation have been deposited in situations subject to marine inundations, as they are interstratified with rocks containing sea-shells, the roof in some pits being filled with their remains: on the other hand, the coal beds of the upper division (those worked in the Newcastle district) have been formed in places subject to irruptions of fresh water, since we find their associated strata containing the remains of fresh-water shells. The more recent vegetable deposits on the Yorkshire coast are similarly circumstanced, as we find *Ammonites* adhering to logs of jet, and a true *Unio* in the plant beds of Gristhorpe.

Wm. King,
Lecturer and Supervisor of Museums.

North of England Museum of Scientific and Economic Geology, Newcastle-on-Tyne.

* It is probable that some of the readers of the 'Practical Mechanic's Journal' may be unacquainted with the terms used in this communication; but they will find them sufficiently explained in a paper which I published in vols. xxxvi. xxxvii. and xxxviii. of the 'Edinburgh Philosophical Journal,' entitled, 'Contributions towards Establishing the General Character of the Fossil Plants of the Genus *Sigillaria*.'

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

President's Conversazione, May 30.

Mr. Field, the President of the Institution, held his annual Conversazione on the 30th of May last. The previous meetings of this kind have hitherto been held at the residences of the Presidents, but the numbers of the members increased so much, that no ordinary house could receive them, with the guests invited to meet them. In arranging, therefore, the recent alterations in the House of the Institution, special provision was made for these meetings, and we must give our unqualified approbation of Mr. T. H. Wyatt's design for these arrangements, and of the manner in which they were applied; for when the extensive suite of apartments was lighted up, and decorated with works of art and mechanical models, and the staircases and corridors lined with choice plants, the *coup d' œuil* was charming. The refreshment-rooms were extensive, and the cheer was on the most liberal scale, as might have been expected from the well-known kindness and hospitality of the President, who was well supported in the reception of his guests by the Vice-Presidents and Council, and Mr. Manby the Secretary, upon whom devolved the duties of the selection of the models and works of art, and all the arrangements of the evening.

From so extensive a collection, our limits will only permit our noticing a few of the principal objects, and even those cursorily.

Upon the walls were the three fine portraits by Lucas, of Mr. George Stephenson, Mr. Robert Stephenson, M.P., and Mr. Bidder—they were contributed by Messrs. Graves, for whom they are about to be engraved.

Messrs. Colnaghi's collection of the copies of Corregio frescoes by Toschi, occupied a very deservedly prominent position, and the drawings by Nash, Lance, Scanlan, Taylor, and others, with portfolios of sketches by Oliver, Hildebrand, Digby, Wyatt, and others, excited general attention.

A trophy, carved in beech, by Taylor, Williams, and Jordan's mechanical process of carving, was seen to great advantage. The Electric Telegraph Company—Mr. Bain, Mr. Brett, and Mr. Reid—contributed instruments exhibiting their various systems of telegraphic communication by electric clocks, and electric printing. Mr. Rand's fly-press for raising, at one blow, the collapsible metallic tubes or capsules, now so generally used for containing artists' colours, &c., was incessantly worked throughout the evening. Mr. Whitworth's beautiful machine for knitting stockings was worked by a young girl sent up from the factory of Messrs. Ransome and May of Ipswich, and formed a most attractive object.

The models of greatest interest were those of Mr. Stephenson's wrought-iron tubular bridge of 400 feet, erected at Conway, with that of his wrought-iron tubular girder for large spans. Mr. Fowler's steamboat floating landing-stage, with its long approach over the mud banks, all to be supported upon Mitchell's screw piles, for the Hunber Ferry. Mr. Brunel's excellent truss of 110 feet span, used by him in the Somerset bridge on the Bristol and Exeter Railway. Mr. Fowler's plan for opening or shutting simultaneously four gates, for a level crossing on the line of the Manchester, Sheffield, and Lincolnshire Railway. Messrs. Taylor, Williams, and Jordan's model of their machine for carving by machinery ornamental objects, figures, or groups, such as we have previously noticed. This machine, by means of a tracer which guides the cutting tools, is enabled to perform the most delicate and elaborate work with great speed, and at a cheap rate.

Messrs. Seaward and Capel contributed such a large collection of models of paddle-wheels and screw-propellers, as almost to illustrate a history of marine propellers. Some of them, as well as their own method of raising and lowering the screws at the stern of vessels, were contrived with great ingennity, and the models were beautifully executed; indeed, so perfect a set of models is rarely seen.

Messrs. Maudsley and Field also contributed an interesting series of models of steam-engines, screw-propellers, and paddle-wheels; as did also Mr. Penn, of his horizontal trunk steam-engine.

Mr. Clarke exhibited a beautiful model of the Great Britain steamer full rigged, and containing *fac similes* of the engines, with the screw-propeller complete, and working by means of condenser air, the whole only weighing *one ounce*. As a piece of ingenions workmanship, this could scarcely be surpassed.

Mr. Cowper exhibited a very ingenious system of determining the resistance of screw-propellers.

Messrs. Clarke and Varley's atmospheric pile-driving machine, and Mr. Varley's rotating air-pump, were both very useful machines. Mr. S. P. Bidder's simple and effective coal-drops, Mr. Dodds' rail-straightening machine, Mr. Southam's wedge and screw fid, Mr. Thornton's improved hydraulic lifting-jack, Mr. Wetherall's iron-twister, Mr. Beattie's new wooden railway, with the drawing of the system of manufacturing it—were all most interesting, as was also the model of a folding boat, of which each side was made of two thickness of waterproof cloth, filled in on Captain Light's principle with very buoyant reeds, rendered non-absorbent, and consequently rendering the boat incapable of sinking, even when full of water, and even when partially torn by accident. The expedition in search of Sir John Franklyn, has been furnished with boats of this description, in order that they may be easily transported across the ice, and may bear injuries which would destroy a wooden boat. Life-buoys, swimming-belts, &c. were with the boat, as also a model, showing the system of transferring an ordinary wherry into a life-boat by the use of this material, as in the case of the wherry recently built for his Royal Highness the Prince of Wales.

The Gutta Percha Company sent an excellent selection of their products, from the rough material throughout all its stages of manufacture to the finished article.

Mr. Chubb's safety-chest, with locks and keys, M. De la Fon's ingenious locks and bolts, Mr. Dehries' improved dry gas-meter, the new aneroid barometer, Mr. Shepherd's model of self-acting gates, with numerous other models and specimens—all interesting, and inviting longer examination, but which space will not allow us to notice—so completely occupied the attention of the members and visitors, that it was not until an early hour in the morning that all had departed, after partaking of the President's hospitable reception. The same reason prevents the enumeration of the names of the visitors; for, among upwards of a thousand guests, it was too difficult a task to ascertain who were there. We can only say, that we have seldom seen more unanimity in the determination to be happy, and make others so; and we trust that, having so prosperously commenced the *conversazione* at the House of the Institution, they may continue to be held there, and be of great benefit, not only to this useful Institution, but to others, in inducing them to follow so good an example.

June 20.

The paper read was "On Harbours of Refuge." By the Right Hon. the Earl of Lovelace.

It consisted chiefly of a succinct review of the Reports of the Commissioners on Shipwrecks and on Harbours of Refuge, giving the opinions of the naval officers and civil engineers on the necessity for harbours in certain situations, the naval qualities possessed by those positions, and the possibility of constructing harbours in them, and the nature of the structures. The necessity for harbours on our coasts, capable of sheltering fleets from storms in peace, and the enemy during war, appeared to be admitted, particularly at the present moment, when the disturbed state of the continent and the restless character of our near neighbours were considered. It was stated, that of various situations pointed out, that of Dover was the only one yet decided upon, although great works are contemplated at Portland, where, from Mr. Rendel's designs, a system of construction would be adopted, which would be both economical and stable. and, at the same time, would afford employment to a class of persons, whose labour it had been difficult hitherto to use efficiently.

The various projects of floating breakwaters and other artificial shelter for vessels were then examined, and were generally condemned as entirely inefficient for the objects proposed.

The questions relative to the movement of sand, the drifting of the shingle, and the deposit of silt in the Dover Bay and other places, were treated at great length, and reasons given for the various forms of construction, and of the projects for meeting the difficulties induced by those circumstances.

The next question was the plan of the harbour and the mode of construction of the works. After quoting all the authorities on both sides, including the naval officers, the commissioners, the civil engineers, and the scientific writers, the preference was given to a large harbour with two entrances, so placed as to allow a sufficient run of the tide through it, to prevent any very considerable deposit of silt, but so constructed as to afford shelter to the vessels within; the pier walls enclosing the harbour to be built vertically up from the bottom, or with a very slight inclination in their height, instead of throwing in masses of rubble stone to find its own angle of repose, which it was shown was not less than four or five to one, and that it only attained solidity after a lapse of many years, even with a due admixture of small materials to fill up the interstices, and after constant supplies of stone, to replace that which the seas removed. The reports of Captain Washington were quoted to prove the failures that had occurred at certain harbours in Ireland, where it was stated that the long slopes had been destroyed by the sea, and had ruined the harbours they were intended to protect. The proceedings at Cherbourg and Plymouth were followed in great detail, with a view to deducing arguments against the long slopes, and in favour of vertical sea-walls. The protest by Sir Howard Douglas in favour of long slopes was examined at great length, and the arguments used on both sides were analyzed with skill and candour.

Colonel Emy's theory of the effects of the "flot du fond" was carefully examined; and, without going to the entire length that he did, it was admitted that, in many cases, the effects produced were as he described them, and that the subject, as he had brought it forward, was well worthy the attention of civil engineers. The placing a vertical wall upon a substratum of rubble, in the form of a long slope, was shown to be pregnant with mischief, and had never been successful; and that the adoption of that system at Cherbourg had been a matter of necessity rather than of choice.

INSTITUTION OF MECHANICAL ENGINEERS, April 26.

Concluded from page 71, *June.*

George Stephenson, Esq. President, in the Chair.

The next paper on the list, "On a Boiler and Condenser suitable for extending the Cornish Economy, and for preventing Boiler Explosions," was read by the author, Mr. T. Craddock. A small working engine was also placed before the members.

"In submitting to the meeting the subject of this paper, it appears desirable to call attention to the well-established practical data, from which, by the Cornish system of generating and using steam, such economical results have been obtained. To this end, a very brief review of the various laws or principles immediately bearing upon the subject, seems to be essential for placing the matter in its proper light before the meeting. For this purpose, perhaps the classified mode is the preferable one.

"Firstly,—We have to do with the laws by which heat is transmitted from hotter to colder bodies, and *vice versa*. These demand in our steam-boilers and condensers an extensive surface, and, as far as other circumstances will allow, that such surface be composed of thin metal. It is further necessary, if we would produce the greatest ecouomy in the generation of steam, that the heat produced in the furnace be, to as great an extent as possible, absorbed by the water; this is best effected by a subdivision of the gases, by a slow draught, and by completely surrounding the combustible matter in the furnace by the water in the boiler.

"Secondly,—The hydrostatic laws require, in order to render high-pressure steam equally safe from explosion as low-pressure, that we diminish the sectional area of the interior surface of the boiler upon which the pressure of the steam acts, in the same ratio as we increase its pressure. If we do this, then the rending force, tending to burst the boilers, remains the same at whatever pressure the steam be generated.

Thirdly,—"The laws relating to latent and sensible heat, when considered in combination with large volumes of water, and subjected to the casualties attending the steam-engine, suggest the diminishing the quantity of water necessary in steam-boilers, as far

as practical circumstances will permit, as one of the surest means of preventing destructive boiler explosions. The importance which attaches to the suggestion these laws present, becomes apparent when we consider the effects in case of explosion, which such an amount of sensible heat produces as that contained in the large volume of water necessitated in boilers of 60-horse power, for instance, and of the usual construction, as the sensible heat contained in so large a volume of water would, supposing the pressure of the steam to diminish from 40lbs. to 20lbs. per square inch, generate a volume of steam at 20lbs. pressure, equal to 30,000 cubic feet. Here we have a cause equivalent to the diffusive and destructive effects exhibited in common and large boiler explosions. The boiler to which this paper refers reduces the danger from this cause nine-tenths, though the steam be generated in it at a temperature and pressure of 100lbs. per square inch. In this case, we find the sensible heat contained in the water required by such boilers would give but 3000 cubic feet of steam at 20lbs. pressure. The boiler under consideration is equally successful in diminishing the risk from explosion, arising from the rending strain due to the pressure of the steam; as, on a comparison with the common boiler,—in which we suppose the steam at only 36lbs. pressure,—we find the rending force in it 5400lbs., whilst in the tubular, even with 100lbs. pressure, the rending force amounts only to 900lbs., or but one-sixth of that given in the instance of the common boiler. The most obvious and certain conclusion to which such well-established principles lead, cannot fail to show how ill-grounded and unscientific must be the objections raised against high-pressure steam when generated in such boilers.

"Fourthly,—The laws relating to the expansive action of steam plainly indicate the importance of the two leading features of the matter before the meeting, namely, that of removing the atmospheric pressure from the exhaust side of the piston on the one hand, and on the other, enabling us to make use of high-pressure steam with safety, as, by the removal of the atmosphere in non-condensing engines, an economy is produced by this cause alone, equal to thirty-eight per cent., and by increasing the pressure of the steam at the commencement, we can obtain a further increased economy upon the Cornish system, equal to forty per cent.

"My boiler and condenser form part, only, of arrangements which have been practically proved to give the following advantages:—

"An increased extent of grate surface.

"A slow state of combustion.

"Great extent of heating surface for the fire to act upon.

"Increased facility for generating the quantity of steam required.

"Water free from deposit for the use of the boiler.

"Removal of the atmosphere from the exhaust side of the piston.

"Insurance of safety from explosion.

"Great facility for generating the steam under higher pressure, by which the expansive principle is much extended.

"Diminished tendency to priming.

"An effectual means of preventing the loss arising from steam blowing away at the safety-valve.

"Self-adjusting means for keeping the steam at a uniform pressure, whatever the pressure desired may be.

"A continuous supply of pure water for the use of the boiler; it not requiring a *fresh* supply of more than one gallon per horse power, per day, to make good that lost by leakage.

"The engines and boilers compacted into a much less space, and not half the weight for equal power as those in general use.

"THOMAS CRADDOCK."

Birmingham, April 26th, 1848.

The President inquired whether there would not be a liability in the top and bottom chambers to give way?—Mr. Craddock replied that he had had these boilers in use for five years, and he had worked them as high as 130 lbs.; but in general from 60 to 80 up to 100 lbs., and he had never detected any leakage whatever.—The President: You expect a saving of fuel in this, I suppose?—Mr. Craddock: I do; but I am not at present prepared to submit the exact amount.—The President: What vacuum do you get?—Mr. Craddock: I have got from 24 to 26 inches, mercury, and I do not despair of getting 28. I hope to be able very shortly to show an engine of 40 horse power, which shall not take half a horse power to drive the condenser. It will not take so much power to work the air-pump on this principle, as by the injection system. I do not propose this as a substitute for water, by any means; but I propose to carry that principle into every place where air can be obtained, so far as other practical circumstances will admit.—The President: I think it requires a very ingenious mind to follow you.—Mr. M'Connell inquired if any trial had been made of the engine in actual work; to which Mr. Craddock replied that it had been tested at the London Works at Smethwick, and referred to Mr. Cowper of that establishment for the particulars of the trial.—Mr. Cowper: Mr. Craddock brought the engine to our Works, and, as near as I can remember, the results were—that the horse power was 22 and a fraction, indicator horse power; and the condenser took one and a half horse power to drive it. I think it may have been less, but not more, while the engine was doing the work of 22 horse power. The vacuum was 22½, and in a very hot day in August he got as high as 25 inches.—Mr. M'Connell: May I inquire the diameter of the cylinder, the stroke, and the pressure of the steam?—Mr. Cowper: I think the high-pressure cylinder was 7 inches, and the other 13 inches.—Mr. Craddock: The other was 14 inches. The stroke of the one was 16 inches, that of the other 2 feet.—Mr. Cowper: The pressure of steam was generally about 80 lbs.; but that varied.—Mr. Crampton: I should like to know what proportion the condensing surface bears to the heating surface of the boiler?—Mr. Craddock: I can furnish you with the substance of it. For instance, in an engine of 10 horse power the condenser would be a weight equal to 10 or 12 cwt. The larger the engine, the less would be the proportionate weight; but I can say it would not exceed 12 cwt. for 10 horse power.—Mr. Crampton: We generally suppose 9 feet of heating surface to generate steam for one horse power; and what I meant was, how many feet of cooling surface would condense this?—Mr. Cowper: I think it was, as near as possible, 40 square feet to 41. I think Mr. Hall used, with his water condenser, 20 feet, and Mr. Craddock, with his atmospheric condenser, used twice as much.—Mr. Craddock: I use about twice as much surface for giving out the same quantity of heat; but I think I shall be able to show, that I produced treble the amount of power from the same quantity of steam.—The President: Have you any idea of trying it with locomotive engines as well as stationary?—Mr. Craddock: That depends upon whether I obtain sufficient encouragement; but I think it would be found highly economical there; and hence I have an idea that some day or other it may be so applied.—Mr. Buckle: Do I understand that you generate three times the quantity of steam as a common boiler does?—Mr. Craddock: Certainly no. All I contend for is, that there is a larger amount of surface for the heat to act upon; and I conclude that I get a facility for generating steam which the common system is not capable of.—Mr. M'Connell: What is the proportion of the high-pressure cylinder to the low-pressure?—Mr. Craddock: Six to one.—Mr. M'Connell: And the relative pressure of each when working?—Mr. Craddock: That will materially depend upon the space which there is between the two cylinders for the steam to expand in. It is a matter of experiment only.—Mr. M'Connell: So far as your experience goes, what do you consider to be the relative pressure of the two cylinders?—Mr. Craddock: As four to one.—Mr. M'Connell: Yes that is the area; but the pressure?—Mr. Craddock: Experiment will determine that.—Mr. Crampton: I think he has to expand the steam six times when he has a pressure of 80 lbs. on the atmosphere. Is that so?—Mr. Craddock: It is not fixed.—Mr. Crampton: The expansion of steam is only relative. The general rule is, that at a pressure of 25 lbs. the steam is expanded five times. It appears to me that, in asking questions about the relative capacities of the small and large cylinder, we should always bear in mind the pressure of steam to be worked.—The President: I should like to see the engine pumping water, in order to test it.—Mr. M'Connell: What is the relative consumption of your engine?—Mr. Craddock: I have not carried my experiments so far as to form any rule: but where I derive the economy is chiefly in the expansion of the steam.—Mr. M'Connell: I think it is now some four or five years ago since you first brought it under notice, and I was then anxious to ascertain what its economy was. Now I had hoped, that having acquired more experience, we would have been favoured with statements upon the subject, and also as to what Mr. Henderson's engine did as compared with yours. They were at work at the same place, and you had every opportunity of making the necessary experiments if you had wished it.—Mr. Craddock: I have never directly asked Mr. Henderson; but I have many times thrown out a suggestion that it might be satisfactory to have some experiments made, and the suggestion was never acted upon.—Mr. M'Connell: In dealing with this question, we have to trust entirely to practice; and as to the economy of expanding steam to a certain extent, and that particular system of condensation, I do not think we are prepared to give a decided opinion. The best test would be, as the President has stated, that of pumping water.—Mr. Buckle: Or grinding corn.—The President: Or driving a locomotive engine.—Mr. Craddock: I submit whether the indicator is not a sufficiently good test.—Mr. Crampton: No question of it; but, when talking of economy, we must take into consideration, first, What does the boiler do? how much water do we evaporate for a given surface? When that is settled, then we may ask, how much better is it than another? There is a question whether the two cylinders are better than a single one. Evidently a loss there is in the expansion of steam from the small cylinder to the large one, which you never can get back, and which you avoid by using a single cylinder. There may be a little more equal motion, but that is all you get. I tried them some years ago, and I found that you would lose something like 14 per cent., merely in the travelling of the steam from the small cylinder to the large one. It is, however, desirable that we should come to some settled opinion upon the subject. My impression has always been that there is a loss connected with the small cylinder. Put the same amount of steam in the large cylinder, cut it off, and you will do more work than if you first put it in the small one, and then sent it through to the large one.—The President: There must be a loss. No doubt the Cornish engine does its work more economically from having only one cylinder.—Mr. Crampton: What I want to know is, If the double cylinder is so good, *why* is it so? I cannot find, by any experiments I have made, that there is any reason for it. There is, as I have said, a rather more uniform motion; and that little advantage I think we can get from a fly wheel. We must lose a certain quantity of steam in going through the passage, and the gain of the more uniform motion is more than compensated by the greater economy in having the high-pressure steam.—The President: If you throw the steam into the large cylinder, and cut it off at high pressure, at a short portion of the stroke, you have that steam to expand over the other portion of the cylinder, before it is thrown into the condenser, because this brings the high-pressure and low-pressure systems into action in the same cylinder, and you have as much power in that as you have in two cylinders.—Mr. M'Connell: There is one subject which we have not yet considered, and that is the advantage to be gained from using the revolving air-condenser, as compared with the ordinary jet-condenser of a stationary engine. There is certainly the advantage of using the same water and having no sediment, instead of drawing it up by an air-pump and discharging it.—Mr. Craddock: In reply to Mr. Crampton and the other gentlemen, I may state, that the practice of the profession is in my favour, as regards the use of the two cylinders. Time was, however, when these engines were tried and thrown aside. Let me call the attention of the meeting to the model before us. It is scarcely necessary to remind the members, that in so small an engine the friction is considerable when first started; yet it had worked up to its speed with the steam cut off at 1-60th of the stroke; to get the same effect in one cylinder, would cause great irregularity of motion. Another thing which I have found in the course of my experience—which has been considerable, having been engaged ten years in this matter, seven of which have been devoted in a great measure to experimenting,—is, that those experiments with respect to the relative advantages of the double and single cylinder, have proved to me that, by admitting high-pressure steam direct from the boiler into the cylinder, a considerable portion of it becomes condensed by coming into contact with the comparatively cold metal of such cylinder: the water resulting therefrom, being in contact with the metal of the cylinder, does, when placed in communication with the condenser, again assume the form of steam, which, passing to the condenser, uselessly carries away much heat from the boiler to it, without producing mechanical effect. I suggest that a more conclusive test than that of indicator figures, to which Mr. Crampton has alluded, will be that of two cylinders, one of which could be readily thrown out of action. Such engine being connected with the same boiler, expanding the steam to

the same extent, and performing the same work. The steam and coal required in both cases being accurately weighed. I have made experiments which are perfectly conclusive to my own mind; and I hope shortly to be able to give you an invitation to investigate experiments which will be equally satisfactory to yours.—Mr. M'Connell: There is more than the question of the two cylinders involved in this. There is another principle, and if Mr. Craddock would pay attention to that, it might afford a great deal of information. I allude to the principle of condensing by air, in contradistinction to our ordinary way of condensing by a water jet. If there is economy in that, we get this result, that we have pure water; and we all know the benefit of that in the working of a steam-engine. I merely suggest this, that Mr. Craddock may bring forward at a future period the results of this principle, as well as the advantages it may afford in the generation of steam. It appears to me that the condenser is most valuable for marine purposes.—Mr. Craddock: The advantages of the condenser for marine purposes may be stated in a few words. It would ensure us water free from deposit, thus rendering tubular boilers practicable, they enabling us to generate high-pressure steam with safety, and thus, by carrying out the expansive principle, with other advantages consequent thereupon, a saving of two millions annually, in our steam navy alone, would be effected.—Mr. Jackson: I have for many years looked upon double cylinder engines as compound machines. From the manner in which Mr. Crampton has discussed this matter, it is evident that he could throw some additional light upon it. I therefore beg to move, "That this meeting will esteem it a favour if Mr. Crampton will prepare, and lay before the next meeting, a paper and diagrams descriptive of the experiments made by him on the comparative merits of the double and single cylinder systems." The motion having been seconded, was carried unanimously.—Mr. Crampton assured the meeting that it would give him great pleasure to do anything he could, to elicit information on the subject. He had made some experiments, eight or nine years ago, and he would be happy to go into the question again.

The next paper, "On a Hydraulic Starting Apparatus," by Mr. P. R. Jackson, was read by Mr. Fothergill at the request of the author. The paper was accompanied by a large drawing.

"Various contrivances for connecting heavy machinery with, and disengaging the same from, the prime mover, without producing those sudden shocks which the use of ordinary clutch-boxes occasion, to the serious injury of both the article under operation, and the machinery itself, have of late years been made the subjects of much inquiry. The principal ones in use are those invented by Mr. John George Bodmer, and introduced in various bleach-works in the neighbourhood of Manchester, where they are used in connection with the heavy mangles and calenders to great advantage. Mangles and calenders requiring from 30 to 40 horse power are, by this apparatus, connected with, and disengaged from, the engine, without stopping the same, and without any perceptible shock or noise being produced.

"Mr. Bodmer effects his object by means of levers and knee-joints acting upon a series of segments lined with copper, which are brought into, or out of, contact with the internal or external surface of the rim of the driving wheel, thereby connecting the machine with, or disengaging it from, the driving shaft.

"Now, the author of this paper has thought, that in many cases, water, steam, or gas could be more easily and advantageously applied to force the segments against the rim; and he is about, with reference to the accompanying drawing, to explain a starting apparatus, in which water is employed as the medium of conveying the power to press the segments against the rim of the driving wheel.

"The bevel pinion is supposed to be connected with the engine, or other prime mover, and gears into a bevel wheel, to which is cast a rim, which is turned internally. This bevel wheel turns loose upon its shaft, being lined with a brass bush; the shaft, however, is provided with four projections, through each of which a hole is bored; the centre lines of these holes lying in one horizontal plane, and meeting in one common central chamber. Into these holes four rams, which are respectively cast of one piece with the friction-blocks, are fitted; the blocks being lined with copper, and turned so as to fit the internal surface of the rim. Supposing now, that the machinery which is assumed to be connected with the shaft, required to be started, hydraulic pressure is applied to the rams by pressing the additional ram down upon the column of water within the shaft and the chamber, by means of a fly wheel, with its nut and screw, which forms one piece with the ram; the ram, nut, and screw being guided and supported by a brass box, which is screwed into the upper end of the shaft. It is evident, that on the ram being thus pressed down, the four rams will gradually and simultaneously press the segments against the internal surface of the rim, with a power proportionate to the force applied at the circumference of the fly wheel, until the friction produced by such pressure shall be equal to the resistance of the machine to be set in motion. The machine will, therefore, gradually assume the velocity which, according to the speed of the driving shaft, it ought to have; at the same time that any extraordinary momentary resistance, such as might be supposed to occur occasionally in rolling mills, or other machinery of a similar nature, instead of causing the wheels to break, will have a tendency to make the rim to slip on the segments until the obstacle be removed or overcome.

"In order, however, that too great a pressure may not be applied to the four rams, the actuating ram and screw are perforated with a small opening, the extremity of which is closed by a valve, acted upon by a spiral spring, encased in a brass box, which is screwed to the top part of the screw; so that if at any time the pressure exerted upon the rams should exceed that to which the spring is regulated, the water would lift the valve and escape through it into the box, and, through an opening in the lid of the latter, into the atmosphere, until the balance of the pressure was again established.

"On the segments requiring to be brought out of contact with the internal surface of the rim, it is only necessary to hold fast the fly wheel, inasmuch as the screw has a right or left thread cut upon it, according as the shaft turns either to the left or the right, and the rams are therefore immediately relieved, wherenpon the machine stops.

"It may be observed, that the vacuum which is created in the column, by the withdrawal of the ram, will in most cases be sufficient to cause the segments to recede from the surface of the rim, otherwise that effect might be produced by the application of springs, or an elastic hoop.

"The rams are made good with press leathers, in the ordinary way of hydraulic presses."

In answer to a question, Mr. Jackson stated that he had had the apparatus at work for two or three months, and it had acted very well, and he thought that by it he had saved some horse power.—The President: I think it is very ingenious, and calculated to be useful.—Mr. M'Connell: I observe that the regulation of the pressure upon the cone is provided for by an escape-valve at the top. It is, in fact, a safety-valve for preventing a greater pressure of water upon the rams. What I want to ascertain is, whether you can by any means so determine the pressure, that you can vary it according to the necessity of the case.—Mr. Jackson: You have only to screw the box down tighter.—Mr. M'Connell: Yes, but you may screw it down so tight that you may snap your teeth.—Mr. Fothergill: There is a spring at the top.—Mr. M'Connell: That is what you may call a safety-valve.—Mr. Jackson: Yes, and it will act the moment the pressure becomes too great.—Mr. M'Connell: But supposing it does not act (I am looking forward to that), in such a case you would be worse off than before, for trusting to a self-acting principle.—Mr. Jackson: By pressure upon the wheel the man can tell entirely by the feel.—Mr. M'Connell: I think it is a clever thing altogether.—Mr. Fothergill: Mr. Jackson has arranged it in a similar manner, as regards the pressure of the safety-valves in locomotives, where the spiral spring is introduced. There is a certain spring, and a certain amount of resistance is necessary to allow the water to escape. If the person screws it beyond a given pressure, then this valve opens.—The President: And lets the water out?—Mr. Fothergill: Yes; therefore it is self-acting, from beginning to end. It is very ingenious, and highly valuable.—Mr. Crampton: In case any grease should get in, I think you would require a regulator?—Mr. Fothergill: A greater amount of power would then be required to be transmitted, in order to turn the rollers of the rolling mill; but then there is a regulation to the pressure, for it discharges itself when it exceeds a certain force.—Mr. Crampton: May I ask what the objection is to the cones?—Mr. Slate: They get oval, and consequently jam themselves.—Mr. M'Connell: They begin to twist round, and get unequal in the surface, and only bear upon the point.—Mr. Fothergill: There is a great deal of lateral action where there is a cone.—Mr. Buckle: There is considerable lateral action, and the pressure is directed endways; besides, there is a danger of sticking.—Mr. Slate: I have seen a cone stick several times a day, and no ingenuity could avert it. The remedy was to put in a little oil, after which it would go on, but only for a day or two.

Mr. Cowper said he had had the conical clutches in use many years, and if the angle be made just below the angle of friction, the pressure is moderate, and the cones do not stick.

Mr. Slate: You will always find it more or less difficult to define the angle of friction. The size of the cone I spoke of was fourteen inches at the top—I don't recollect the taper; but it could easily be thrown out. It would break cast-iron spindles of two or three inches.—Mr. Crampton: I was yesterday in a large dredging boat, where the cone had been put in by Mr. Humphreys of London, one of the council of our Institution; the cone was four feet in diameter, but the principle had been altered, and it answered beautifully. Mr. Humphreys had made one before, but had not got the right angle of friction, and he had put this one in, which he conceived to be right; and when I saw it, it was going on well. Mr. Humphreys has a scheme for taking off the end pressure.—Mr. Cowper: I can appreciate that. The first cone I made was not a right angle, and it stuck fast. It was one in 13—I have since made them one in 6, and $6\frac{1}{2}$, and $6\frac{3}{4}$, and they work very well; but they must have some end pressure.

Mr. M'Connell: There is no way to take off the end pressure without putting on a side pressure, in order to get the requisite hold to turn the shaft; and that I conceive is the point where great advantage will be gained by Mr. Jackson's mode,—that he, without any pressure at all, by this expanding mandril (if we may so term it), suits the inner cylinder to the surface, or rather the inner cone to the surface. The only point not clear to me was the safety-valve; if it acts like the one annexed, and gives way just before the point of breakage, then we have everything we desire. There is great objection to the ordinary cone. If a piece of grit, or too much oil gets in, you are sure to have an accident, whatever the angle is.—Mr. Jackson: I have never seen a cone which would drive anything like the power that this is calculated for. The rollers were 3 to $3\frac{1}{2}$, and I have never seen a cone which would turn three horse power.—Mr. Crampton: Oh, the one I refer to was about 35.—Mr. Jackson: Another objection to the cone is, that the surface does not wear equal.—Mr. Cowper: The cone I speak of did wear equal.—Mr. M'Connell: I think we are much indebted to Mr. Jackson for the introduction of this apparatus; it is very ingenious, and I think it possesses many advantages. I think that he is entitled to the thanks of the Institution. There can be no two opinions as to his plan being quite superior to the ordinary cone; and I beg to move, "That the thanks of the meeting be given to Mr. Jackson for introducing the subject to our notice." Seconded by Mr. Cowper, and carried *nem. con.*—Mr. Fothergill: I think a communication of this kind ought to be made known to those of our members who have not had an opportunity of attending this meeting. I beg leave, therefore, to move, "That Mr. Jackson's paper, and accompanying drawing, be printed and circulated among the members." The motion having been seconded, was unanimously carried.—The President then called upon Mr. Buckle to read a paper "On Chesshire's Safety Buffer."

Mr. Buckle: I beg to claim a little of your attention while I endeavour to describe what appears to me to be a very useful appendage to a railway train. I am of opinion that this apparatus, accompanied by the spiral break of our worthy President, will do all that can be done in averting the serious calamities attending the casualties on railways. The following is Mr. Chesshire's paper:—

"The object of this invention is to lessen the injurious effects of collisions on railways, both to the passengers and the carriages of the train. To attain this, it is proposed to place in the rear of each train a strong van, which may be made applicable, if thought desirable, for the conveyance of luggage or goods. In the front of the train the tender is proposed to answer the same purpose as the van behind—the centre of gravity of each to be nearer the level of the rails than that of the other carriages.

"Each carriage is to be supplied with a strong moveable rod of iron, either a tube or a solid, supported in the centre of the under framework by bearing sockets. The rod is intended to have, simply, an endway motion. Each safety buffer is to have a head at each end similar to the present side buffers, but the heads of the safety buffers are not intended to act against each other except in cases of collision. When the carriages are screwed up into their ordinary travelling state, there will still be a space between the safety buffers of some few inches, to permit the usual action of the side buffers, without acting at the same time upon the safety buffer.

"In the van in the rear, and the tender in the front, the safety buffer will be fixed, so that, in either case, it cannot have an endway motion further than being fixed against strong elliptical springs will permit of, if such springs are thought desirable.

"It will be perceived that, in case of a collision, the moment the side buffers have been driven home to the extent of the interval between the safety buffers, the force of the collision will be instantly imparted to them, and be conveyed by that means from buffer to buffer, to the further extremity of the train, either to the van in the rear, or the tender in the front, according as the collision may happen to occur.

"The safety buffer would, it is fully expected, have also the effect of preventing the carriages from riding one on the top of the other, which was the case in the Wolverton, the Nottingham, and other collisions, and the cause of so much destruction."

After the paper had been read, a series of experiments were made on a model railway erected at the back of the theatre. A train of carriages with the safety buffers was started from one end of the line, and another without them was set in motion from the opposite end. A collision took place in the centre of the line, and the carriages to which the safety rods were fixed remained upon the rails, with the exception of the luggage van behind, while those without the rods were scattered about in all directions. The shock was received by the van, which, as Mr. Buckle stated, was intended to be loaded with heavy luggage.—The President: I think one of the points must be to take the mass and the momentum, to see what the velocity is. It will surprise some of you who have not paid attention to these matters to know, that supposing a train starts with sixty waggons, the last waggon receives the greatest shock upon starting. The question is, therefore, whether, without these safety buffers, the last carriage does not get the shock. The momentum, or force, has to be stopped somewhere, and can't be got rid of.—Mr. Buckle: The shock is conducted to the last carriage, which Mr. Chesshire proposes to have filled with luggage. The public require that some experiments should be made with the view to avert the serious calamities occurring on railways, and this invention should, at least, be put to the test.—The President: The momentum must be taken up by something, and what is that something to be? You may try any scheme, but you can't prevent the momentum of matter coming upon the engine in the event of a backward shock.— Mr. M'Connell: I am afraid there are practical objections to this invention, which would render it difficult to get the shock transmitted throughout the train. We know the difficulty there is to get the ordinary buffers all ranged horizontally on a line with each other. Now, if this rigid bar is not transversely and horizontally in a line, I imagine it would not have the effect of transmitting the shock in the manner intended by Mr. Chesshire, and it would be liable to bend; so that, in order to have this scheme to act perfectly, (supposing the principle to be right,) it would be necessary that the carriages should be all of one height, and they must be in a straight line when the blow reaches them to be of any effect. On a curve, the tendency would be to throw off the middle of the train, and not the end carriage at all, as forces go in a straight line. No doubt the last carriage receives the shock, and the centre carriages escape comparatively unscathed; but there are so many practical difficulties connected with carrying the plan into operation, that, looking at the number of cases in which it might be useful, and those in which it would not act as it is intended, it appears to me very problematical whether it ought to be brought into use.—Mr. Fenton: A curve is the place where the principle would not act, and I believe that that is the most likely part of a railway to meet with collisions.—Mr. Chesshire: That collisions occur most frequently on curves I believe is an error. I have been in conversation with an eminent engineer, who stated, that the very place where he would anticipate a collision, was the very place where it did not occur. They rarely happened on curves, because there the driver was more particularly on the look-out.—Mr. Joseph Wright: An objection which I see to Mr. Chesshire's scheme is, that all the carriages must be constructed upon the same principle; for, if any one has not that apparatus, it becomes inefficient; the connection having been broken.—The President: Yes, there are now many thousands of carriages at work, and it would be a serious matter to alter them all.—Mr. Wright: Besides, I don't see a proper mode of connecting the carriages. It is necessary that the ease of the carriages should be consulted, as well as the safety; and, therefore, that the carriages should be screwed up tight; and I think the means of connection is destroyed by the longitudinal rods. With them you can't apply the screw in the same way as at present. But suppose the collision takes place upon an incline, and the last carriage is thrown back, as proposed, where will it go to?

A Member: To make another collision!

Mr. Wright: Yes, most likely it will. I don't think the plan is sufficiently matured at present, to be brought into practice; or rather, I may say, it is too late to bring it into practice, because there are so many thousands of carriages now in use, that the alterations would involve an expense which no company would incur; and in cases of lines running into each other, such as the London and North Western, where there are nine different lines intermixed, the plan would be impracticable.—The President: I think there would be great difficulty in bringing the invention into use on old railways.—Mr. Buckle: Have you ascertained the cost of fitting up the apparatus?—Mr. Chesshire: It would be about £6 or £7 per carriage.—Mr. Wright: Then there are between sixteen and seventeen thousand carriages in operation on the London and North Western; and if you multiply that by seven or eight, you will find that the great cost raises an objection which will be difficult to get over, particularly at the present time, when the companies have no money to spare.

Mr. M'Connell: I think public safety is the first consideration; and a little expense ought to be borne, provided it is to obtain that object; but the objection which Mr. Wright has stated, would operate very strongly against the adoption of the plan before the meeting, unless there was some government enactment, binding every company to adopt it. We ought, however, to look at it as a question of principle. It is the duty of those who are intrusted with the practical working of railways, to point out, as far as experience guides them, the difficulties that would be met in carrying any scheme into operation; and it is very clear that in adopting this buffing apparatus, it would be necessary to alter the mode of connecting the carriages, and that must be done so, that when you come to adopt it you may find, that although you have a problematical advantage one way, you have a decided disadvantage the other; and if the rods prove to be too light, and that they bend or swerve, I can easily imagine that the consequence would be the total destruction of every passenger in the carriage where the rod broke. I believe that every one would be smashed to atoms, because into that particular carriage would be landed the effect that was intended for the last carriage. Supposing, also, a collision to take place in the usual way, the present buffers would receive the shock in different proportions.—Mr. Wright: The amount of force is expended before all the buffers are brought into action. There used to be a stationary buffer at Euston station, and on a recent occasion a train went too far, and ran into it. The check was received by the first carriage, and by the time the shock reached to the last, its power had been so expended that the passengers in it knew nothing of the collision.—The President: I was once on a train where two men were killed by a collision, and in the fourth and fifth carriages the shock was not felt in the least.—Mr. Chesshire: I think the safety of the public positively demands that something of the kind I propose should be brought into practice. I had an interview at the Board of Trade with Lord Clarendon and General Pasley, and submitted my model to them, of which they approved. I am quite satisfied, that if this Institution were to recommend my improvement, every railway company in the kingdom would take it up. As to the objection of its interfering with the couplings now in use, I would say, why confine ourselves to these particular couplings? I am confident better ones might be introduced.—Mr. M'Connell: Mr. Chesshire should not lose sight of this, that if a train comes up, and it is proposed to transmit its force backwards through these buffers, it has, nevertheless, the momentum of all the other carriages coming up to it. It would transmit its force through the rod to the last carriage, which, naturally enough, would break its couplings and fly back; but still there is the whole momentum of the train at 30 miles an hour coming up against the engine, which you would stop so suddenly.

Mr. Peacock: Supposing a train of carriages to run against a dead stop, or a stationary buffer, at the rate of six or eight miles an hour, the first carriage of course stops momentarily, the second carriage receives a less amount of shock, the third still less, and so on, till towards the end of the train it becomes insensible. That is the effect of our present system of buffers. The only difference between them and Mr. Chesshire's is this,—that his method would communicate the shock to the first and last passengers at the same time, instead of distributing it gradually, so that we should lose the advantage afforded by the present system.—Mr. Cowper supported the view taken by Mr. Peacock. The invention, he said, amounted only to stiffening the under frame of the carriages.—Mr. Chesshire reminded the meeting that he did not contemplate interfering in the least with the side buffers. His plan would admit of the side buffers of all the other carriages acting, because the shock would be so instantaneous, that the last carriage would be disconnected before the others came in contact.—Mr. Fothergill: The buffers would not, I think, be of any use with these rods, because they would not come in contact before the force was expended throughout the whole of the train, and you ought to fix upon a good distance for the buffer to work in satisfactorily.—Mr. Ramsbottom: With the present system, if the buffers are supposed to have a range of 12 inches, we do not get a dead shock; the first carriage will have to move through a space of two feet before its motion is arrested; the next carriage will have six, the next eight, and so on; and we can easily suppose the continued action of the whole of the buffers to be equivalent to putting on a break for two or three hundred yards. But if we look at the action of the safety rod, it is clear that the shock must be conducted simultaneously to the whole of the carriages at one time, and the whole velocity of the carriages resisted in the space of one foot; making the shock much more severe in proportion, if the ordinary buffers are not intended to go home till the rods come into play.—The President: You don't stop a bit of the momentum, but only carry it to the end of the train.—Mr. Chesshire: It is transferred to the van, and there it is expended.

Mr. M'Connell: I think Mr. Chesshire had better let this matter now be ended here. We seem not to agree upon the subject, and I would recommend him to have a conversation upon the matter privately with the Council. They may perhaps be able to convince him that there are objections to his plan which he does not see at present.—Mr. Crampton: I have been endeavouring to make myself acquainted with the invention, and though I confess I don't feel very clear about it, yet the result of the experiment which we have witnessed occurs to me, and I really think there is something in it. I think it is worth our attention, and we ought to look at the thing in a scientific point of view, in order to learn whether it is right in principle; because if it is, the difficulties made by Mr. Wright ought not to stand in the way.—The President: I want to get something to take up the momentum, and Mr. Chesshire has not managed to do that.—Mr. Ramsbottom: The shock cannot be received fairly if it is received either above or below. There will be a tendency to throw the train off the line. If the shock is distributed over a great space of matter gradually, it is divided, and the less severe will it be to the passengers.—Mr. Chesshire thanked the meeting for the very patient attention they had paid to the subject; but he was still of opinion that, by the plan he proposed, the first and great shock must be conveyed through the safety buffers to the van behind the train, leaving the carriages uninjured.—Mr. Fothergill then read a statement of facts relative to "Banks's Patent Steel Tyres," for steeling the tyres of railway wheels.

The statement went to show, that after an experience of five years, it is ascertained that the cost and durability of Staffordshire tyres steeled on this plan, as compared with the Low Moor tyres, is:—

LOW MOOR (YORKSHIRE); THREE FEET WHEELS.

Four tyres of 3 cwt. each = 12 cwt. at 22s	£13	4	0
Putting on the tyres ready for work	8	0	0
Twice turning up, after wearing hollow	1	0	0
	£22	4	0

Suppose these tyres to run 50,000 miles on an average, it would give 50,000 miles at a cost of £22 4s.

STAFFORDSHIRE; THREE FEET WHEELS.

Four tyres of 3 cwt. each = 12 cwt. at 12s	£7	4	0
Putting on the tyres ready for work	8	0	0
Steel for steeling one set, 1½ cwt. at 42s	3	3	0
Wages, turning grooves in wheels	0	10	0
Ditto, inserting the steel	0	10	0
Ditto, turning up after steeling	0	10	0
Ditto, drilling and rivetting	0	7	6
	£20	4	6

These tyres are proved to run 18,000 miles before steeling, and 100,000 after steeling; making a total of 118,000 miles at a cost of £20 4s. 6d. The 50,000 deducted from 118,000, leaves 68,000 miles in favour of the Staffordshire tyres; besides a saving in cost of 39s. 6d. per set,—the cost of the Low Moor tyres being 8s. 10½d. per 1000 miles, whereas that of the Staffordshire is only 3s. 5½d. The tyres are not, of course, worn out alike on all railways; but on those lines where the iron tyres will run more than is here stated, the steel tyres will run more in proportion, and the plan is attended with no danger whatever. This statement shows only the advantage of steeling the tyres once; but many have been steeled a second time, after having run the above-mentioned distance. The cost of the second steeling is £5 per set, for which they will run 100,000 additional miles,—making a total of 218,000 miles, at a cost of £25 4s. 6d. or 2s. 4d. per 1000 miles. The general objection made is, that there will be much trouble in carrying out the plan; but such is not the case. When the wheels require turning up, they must be taken from under the carriage or waggon, and when so taken, the cutting of the grooves in the tyres for the steel will not cost more than 5s. per pair in wages. When the grooves are turned, one smith and three strikers will insert steel segments into ten pairs of three feet wheels, in one day of ten hours; after which, turning up the steeled wheels will take very little more time than turning up without steeling—which proves that the trouble will not be so great as some people imagine; and nothing, when the durability and saving which is effected, by the tyres being steeled on this plan, is considered.

The statement was accompanied by a recommendatory letter from Mr. Jenkins, locomotive superintendent of the Lancashire and Yorkshire Railway, dated 28th January last. It stated that these patent steel segments had been inserted in the wheel tyres of the engine "Oldham," and that she had run 58,866 miles with them when her crank axle broke; the wheels were then taken off, and were not again used until they were put to the engine "Queen," on 12th November, 1846. From that time to 31st of December, 1847, they ran 29,482 miles, making a total of 88,348 miles; and should no accident occur, Mr. Jenkins is of opinion that they will run 40,000 or 50,000 miles more. He believes that there is a great saving of expense in using them.

The President said he supposed it was generally known that these tyres did wear well. Some of them were liable to a great loss, but on the whole he thought they made a good wheel.—Mr. M'Connell thought they required to have a strong tyre in the first instance, in order to have sufficient body to prevent the widening of the grooves in which the steel is inserted, and that they also required to be put in very carefully.—Mr. Peacock said he had tried a great number of them, especially upon tenders: indeed he had some which worked five feet wheels, and they answered very well. The principal trials, however, had been on tenders, 3 feet 6 inch wheels, on the Manchester and Sheffield Railway, the gradients of which were very heavy, and he found that on an average they were obliged to change the tender wheels about once in four months. The first which were tried with Banks's mode of steeling ran twelve months. This proved that they were a great saving, for tenders especially. They had had some which ran nearly 30,000 miles under an engine, and they worked very well.—Mr. M'Connell believed there was economy in them, and where there was a great deal of breaking in the wheels, and skidding, the steel would stand much better. But he would really prefer a good tough iron tyre. One of the segments falling out might neutralize a great deal of the good effect.—A Member said he had seen an instance of a segment breaking off, and there was no bad effect.—Mr. Ramshottom said an impression had gone abroad, that Banks's tyre pretended to make a bad wheel good; but the wheel must be good in itself. Some experiments were about to be made to test how far iron segments would be preferable to steel in this respect, as the same body of iron could be made closer in the grain and more durable. At some future time, if thought desirable, he would be prepared to lay before the Institution the result of those experiments.

The business having been brought to a conclusion, the President expressed himself well pleased with that evening's discussions, and he hoped that the next meeting would prove as interesting. Mr. M'Connell's long-expected paper "On the Balancing of Wheels," would be brought forward on the next occasion; and also one from himself, "On the fallacies of the Rotatory Engine." That engine never had, and never could be used to advantage, and his paper would show the reason. It had been tried in Birmingham, and of course without success. Mechanics ought to know the reason of that. Very erroneous notions existed on the subject of the "crank." The crank, he considered, was the most beautiful and efficient motion, and the idea that power was lost by it was a great mistake. It was in vain to attempt to evade the great law of mechanics,—a pound for a pound, a pound of weight for a pound of power,—and no person who knew the law would think of opposing it. At the next meeting he would endeavour to explain the crank to the members, and to make them understand it, although many members of the Institution no doubt understood it well.

THE SOCIETY OF ARTS.

The 94th Sessional Meeting of this Society took place on the 29th of May last, when the prizes consequent upon the exhibition of inventions and works of art, as noticed in page 21 of our April Number, were distributed. Owing to the decease of the Princess Sophia, Prince Albert was absent from the President's chair, and his duties were discharged by the Marquis of Northampton.—We give below a list of the various prizes, with the names of the fortunate presentees:—

IN THE SECTION OF THE FINE ARTS.

Mr. Alderman Copeland, M.P.—"For the combination of Fine Art with Manufacture exhibited in his Specimens of Porcelain and China,"—THE ISIS GOLD MEDAL. Messrs. Minton and Co.—"For the Novelties in Fine Art produced in their various exhibited Manufactures,"—THE ISIS GOLD MEDAL. Mr. Thomas Seddon, Jun.—"For the best Drawings of an original Design for an Ornamental Carved Sideboard,"—THE SILVER MEDAL AND £20. Mr. S. Bendixen—"For the best Monochrome Drawing for a Circular Compartment, being an original composition, half-life size,"—THE SILVER MEDAL AND £5. Mr. William Smith—"For the best Model of a Bracket to support a figure two feet high,"—THE SILVER MEDAL AND £5. Mr. Benjamin Farmer—"For the best Cartoon of an arrangement of the White Lily for a decorative purpose,"—THE SILVER MEDAL AND £2. Mr. Batsford—"For his Specimen of Hand-Carving of the Hawk and Butcher-bird."—THE SILVER MEDAL. Messrs. Coleman and Davis—"For the Ornament and Workmanship of their Marqueterie Table,"—THE SILVER MEDAL. Mr. J. A. Hatfield—"For his Bronze Chasing of the figure of Dorothea, and other works,"—THE SILVER MEDAL. Mr. Frank Hunt—"For his reduced Model of the Laocoon,"—THE SILVER MEDAL. Mr. Magnus—"For his Application of enamel Colours to Slate."—THE SILVER MEDAL. Messrs. Minton and Co.—"For the best Specimen of Turquoise Blue on China, not affected by acids,"—THE SILVER MEDAL. Mr. Pratt—"For producing a fine Work of very large size in Pottery."—THE SILVER MEDAL. Messrs. H. B. and J. Richardson—"For the beauty and purity of their Glass, and for the merit of their works in Engraved Glass,"—THE SILVER MEDAL. Mr. J. F. Christy—"For his Application of enamel Colours to Glass,"—THE HONORARY TESTIMONIAL. The Coal Brook Dale Iron Company—"For the Excellency of its Iron Castings,"—THE HONORARY TESTIMONIAL. Mr. Hall—"For his Mode of discharging Colour from Marble, and giving it the appearance of Relief without destroying the surface,"—THE HONORARY TESTIMONIAL. Mr. Hetley—"For the brilliancy of Colour produced in his Specimen of Stained Glass,"—THE HONORARY TESTIMONIAL. Messrs. Holland and Co.—"For the Workmanship of their Marqueterie Goods,"—THE HONORARY TESTIMONIAL. Messrs. Jennens and Bettridge—"For their skilful Use of the Material in their Manufacture of Papier Maché, and its application to many new purposes,"—THE HONORARY TESTIMONIAL. Messrs. Messenger and Co.—"For the Excellence of their Iron and other Metal Castings,"—THE HONORARY TESTIMONIAL. Messrs. Phillips and Wynne—"For their Wood and Ivory Carving,"—THE HONORARY TESTIMONIAL. Messrs. Stuart and Smith—"For the beauty of Construction and Workmanship displayed in their Grate, and the novelty of combining Metal with Encaustic Tiles,"—THE HONORARY TESTIMONIAL. Messrs. Willock and Co.—"For their application of Terra Cotta to purposes of Ornament,"—THE HONORARY TESTIMONIAL. Master Byron Webb—"For the Front Views of a Head of a Ram, of a Bull, and of a Horse,"—A PRIZE OF BOOKS. Master Charles P. Slocombe—"For a Group of Oak and Ivy Leaves arranged together ornamentally,"—A PRIZE OF BOOKS. Mr. Thomas Woodington, Jun.—"For a Group of Oak and Ivy Leaves arranged together ornamentally,"—A PRIZE OF BOOKS. Miss Mary Ann Shackleton—"For the best Study of Twelve British Wild Flowers,"—A PRIZE OF BOOKS. Mr. Henry Maye—"For his combined Design for a Finger Plate and Lock Furniture to match,"—A PRIZE OF BOOKS. Mr. T. C. Hyne—"For the superior degree of merit exhibited in his Design for a Labourer's Cottage," A PRIZE OF £15. Mr. S. J. Nicholl—"For the superior degree of merit exhibited in the Plan and Arrangements of a Labourer's Cottage,"—A PRIZE OF £10. Mr. J. Colson—"For the superior degree of merit exhibited in his Design for an Intermediate Railway Station,"—A PRIZE OF £10. Mr. C. B. Allen—"For the merit of the Designs on the Panels of a pair of Folding Doors,"—A PRIZE OF £10. Mr. L. W. Collmann—"For his Design of an Ornamental Carved Sideboard,"—A PRIZE OF £5. Mr. T. Browne—"For his Drawing of Figures half-life Size for a Circular Compartment,"—A PRIZE OF £3 3s. Mr. Henry Fitz Cook—"For his Design for a Chandelier,"—A PRIZE OF £2 2s.

IN THE SECTION OF AGRICULTURE.

Mr. Richard Croft Chawner—"For his Essay on the comparative merits of Thick and Thin Sowing,"—THE ISIS GOLD MEDAL. Mr. Gavin Cree—"For his Essay on the Treatment of Forest Trees where early pruning has been neglected,"—THE ISIS GOLD MEDAL. Mr. Sloeum—"For the Introduction into this country from America of various Agricultural Implements,"—THE SILVER MEDAL. Mr. Thomas Smith Tyson—"For his Sackholding Barrow,"—THE HONORARY TESTIMONIAL.

IN THE SECTION OF CHEMISTRY.

Mr. A. Gyde, M. R. C. S. E., Painswick—"For his Essay on the Causes and Prevention of Mildew, especially in Books and Parchment,"—THE ISIS GOLD MEDAL. Mr. T. Ross—"For his method of Preserving Daguerreotypes from the injurious action of light and air,"—THE ISIS GOLD MEDAL. Mr. Naylor—"For his mode of Manufacturing a new Yellow Turpentine Varnish,"—THE SILVER MEDAL. Mr. Kidd—"For his Sample of Olive Oil from Australia,"—THE SILVER MEDAL.

IN THE SECTION OF MECHANICS.

Dr. Potts—"For his Pneumatic Process of Pile-driving,"—THE ISIS GOLD MEDAL. Mr. Pratt—"For his improved Landing Pier for Tidal Rivers,"—THE ISIS GOLD MEDAL. Mr. E. Allen—"For his Mode of forming a Communication between the Guard and Driver of a Railway Train,"—THE ISIS GOLD MEDAL. Mr. Yates—"For his Improvement in the Construction of Lever Watches,"—THE SILVER MEDAL AND HONORARY TESTIMONIAL. Mr. Cunningham—"For his Carriage for facilitating the Conveyance of Life Boats from one part of the Coast to another,"—THE SILVER MEDAL. Mr. W. Stanley—"For his Design for a Timber Swing Bridge,"—THE SILVER MEDAL. Mr. Milton—"For his improved Drill for Miners,"—THE ISIS MEDAL AND £3 3s. Mr. Heley—"For his Flexible Floating Cylinder for the Preservation of Life from Shipwreck,"—THE ISIS SILVER MEDAL. Mr. Woods—"For his Chess Board for the Blind,"—THE ISIS SILVER MEDAL. Mr. Jennings—"For his Improved Water Tap,"—THE HONORARY TESTIMONIAL. Mr. Cracknell—"For his Improved Wrench,"—THE HONORARY TESTIMONIAL. Master Bursill—"For his Improved Soldering Iron,"—A PRIZE OF £2.

ROYAL SCOTTISH SOCIETY OF ARTS, April 10.

[Part II. of Mr. Buchanan's Paper on "The Strength of Materials," concluded from page 71.]

Much valuable information was obtained during the progress of these experiments. The first thing observed was the uniform tension of the under side of the tube when loaded, and the violent compression of the upper side, forming a beautiful illustration of the nature of the tensile and compressive forces already laid down. The former, by its uniform tendency to produce the stable equilibrium, bringing the thin masses into a straight line, the line and position of repose; but the latter, on the contrary, tending to produce flexure in the plates, to push them out of the straight line, and push everything out of joint; so that when the bottom plates remained firm, and retained their form, the top plates became bagged up and puckered like a loose web of cloth. The top plates were, therefore, strengthened, and the addition of another plate to the top increased the breaking weight from 3,700 lbs. to 4,500 lbs.

As it was not so much strength that was wanted on the top plate as stiffness, in place of adding layer upon layer of plates, the idea naturally occurred of forming the top plate into a series of little hollow square tubes running longitudinally the whole length of the bridge, having the appearance, looking end ways, of little cells, the effect which was such, that while the top plates remained firm, the bottom ones now appeared to give way. These being next strengthened, an extraordinary effect was then exhibited when the tube broke, the sides collapsing together, and twisting and distorting the whole fabric in a singular manner, showing that the sides now formed the weak point. These, then, were strengthenedand stiffened hy numerous ribs of angle iron running vertically from top to bottom, and at last, hy these repeated trials, the strength and proportions of the different parts of the structure appeared to have attained a fair and proper distribution. The strength of the tube, which at first only carried seven times its own weight, was then increased to eleven times, and from these experiments the strength and proportions of the real design have been calculated, and one of these tubes, as is known, has now been actually constructed on the shore of the Conway, floated by water to its place, and raised to its proper height by the power of two enormous hydraulic rams, one at each end, lifting the gigantic mass, which is 412 feet in length, 15 feet wide, 25½ feet high, and weighing no less than 1300 tons. This is intended for one set of rails, and there is another tube of the same dimensions in preparation to be set parallel to it for the other.

The situation of the structure close to the suspension bridge, and close to the base of the magnificent Castle of Conway, and the effect of spanning the wide estuary of the Conway, were all illustrated hy a beautiful drawing, and the nature and construction of the Tube or bridge itself, was illustrated by a model which he had himself constructed. The model was composed of only three thicknesses of paper and one of cloth, and the sides were strengthened by thin slips of wood to represent the angle iron; it was 8 feet 6 inches long, 6½ inches deep, and 3½ broad, and although weighing only 4 lbs., it carried a weight of 32 lbs. in the centre, without visible deflection.

The sides of the tube, which are 25½ feet deep at the centre, consist of malleable iron plates, only ½ inch in thickness, rivetted together in plates 2 feet broad, and from 4 to 8 feet long (as was shown in an enlarged view or elevation with cross sections), adjusted so as that the joints may break hand. At the joints, however, the strength and stiffness of these plates is greatly increased by slips of angle or T iron, one of which is laid on the outside of the plate, and the other opposite to it on the inside, face to face, and all the four surfaces strongly rivetted together. The top of the tube, again, consists of two separate horizontal plates, running parallel to one another, 1 foot 9 inches apart, forming together as it were a ceiling to the tube or tunnel and an external flooring on the top. These plates are ⅝ of an inch thick, rivetted together in breadths of 2 feet 9 inches, and in lengths of 6 feet, and between them there run seven vertical plates longitudinally, from end to end of the bridge, 1 foot 9 inches high and ⅝ of an inch thick, separating the ceiling from the floor or upper platform, and at the same time uniting them strongly together by rivets and joints, each vertical plate having a rib of angle iron on each angle running longitudinally the whole length, by which it is united into one vast cellular mass, consisting of eight separate cells or tubes, 1 foot 9 inches square. The object of all this strength and distribution of materials is to give the necessary stiffness and strength where the compressive force acts. And on this account the top and bottom plates are merely united by butt joints with covering plates. The whole sectional area of this cellular frame consists of 608 square inches. Lastly, the bottom of the tube consists of a similar frame of cells, but only six in number. The upper plate consists of two layers of plates, each ½ inch thick, and the under one the same; but as these plates are intended to resist tension, and ought to be formed, if it were possible, like a chain, besides being laid in two layers, the plates are arranged so as to break joint, and a covering plate 3 feet long and as thick as the plate, is placed over every joint with sufficient rivets, such that the tearing strain is equal to the tensile strength of the plates they connect. The plates are 12 feet long and 2 feet 4 inches broad, being the whole breadth of the cell. The angle iron in the bottom cells and plates is rendered continuous hy covers.

The top and bottom are united to the cells by strips of angle iron running the whole length, inside and out; the interior vertical angle irons at top and bottom are curved round to increase the strength of attachment, and there are also gusset or angle pieces rivetted on for additional strength. The rivets used, vary from 1 inch to 1¼ inches diameter, and there are about ¼ of a million in each tube. The holes were made so as to make the rivets fit well, and they were all put in red hot. The sectional area of the bottom frame of cells is 508 square inches.

These are the dimensions in the centre of the tube, hut the top-plates become thinner towards the ends, where they are only ½-inch thick, and also the bottom plates, where they are reduced to ¼ of an inch each. The side plates again get thicker towards the ends, where they are 1⅛ thick. The ends of the tube are stiffened with cast iron frames, and there are also castings in the cells for 8 feet at the ends, and the sides are also greatly strengthened at the ends. The tube was originally curved on the top 7 inches, and was brought to the straight line by the elasticity of the material as calculated on; showing that with its own weight, 1300 tons, it only sunk 7 inches. The one end of the tube is to be fast in the stone pier or abutment, the other is to be loose to allow of expansion, which has been found quite visible in different states of the atmosphere. Mr. Clark states that the line is a sensible thermometer, half an hour's sunshine at one end, or on the top will move it laterally an inch and a half, and vertically two inches, and this when the tube is loaded with 200 tons in the centre.

Such are the dimensions and structure of this extraordinary work, and in regard to which, he was happy to say, the trials which have been already made appear to promise every success. A load of 100 tons only sunk the tube 1 inch in the centre. In regard to the calculations of strength he was not able to enter on these at present for want of some of the data, hut expected to do so on another evening.

2. On a new Lubricant for Machinery. By Mr. Alexander Bryson, F.R.S.S.A., clock and watch maker, Edinburgh.

This paper described a new compound, possessing properties which seem to render it a better lubricant than those in use for large machinery. It is composed of oil, sulphur, and vulcanized caoutchouc.

3. On Economizing Fuel in Gas Works. By Mr. William Kemp, Manager of the Gas Works at Galashiels.

The author states that he has made a valuable discovery in economizing fuel, at Galashiels Gas Works, by which almost all expense of furnace coal is saved.

Where coal tar is burned, it has an injurious effect on the furnace bars and retorts, the greatest annoyance arising from the rapid clinkering up of the furnace bars, to remove which, the firemen had frequently to throw water into the furnace, which caused the rapid destruction of the bars.

To prevent this, the idea occurred to the author, of using the exhausted tan bark of the tan works, which had the desired effect. The force-pump for injecting the tar into the furnace was next thrown aside, as it was found that the dry bark absorbed tar equal to its production at the works.

His method is as follows:—The bark is dried and mixed with the coke of the gas coal, bulk for bulk; a pailful of tar is thrown upon it, not quite so much as it will absorb, and it is then turned over. The mixture burns with a fine clear flame, attended with less smoke than formerly; the furnace bars, hy remaining unclinkered, admit the oxygen freely for the combustion of the fuel. Where tan bark cannot be had, peat moss, loose and dry, makes a good substitute. The author states that in one year £126 was saved on furnace coal; and he has pledged himself that, in in future, not a penny shall be required for that article.

4. "Description and Drawing of a New Plate-Holder for the Daguerreotype Camera." By Mr. Andrew K. Sparke, Devonport.

Mr. Sparke's plan is as follows:—A small mahogany box is made rather larger than three times the breadth of the plate, and half an inch on each end deeper, the width is ⅜ of an inch. A hole is cut in wood the size of the plate, and in the centre of the large pieces. In this box a veneer frame is made with a place for the plate and glass, on a line with each other; this is pulled backward and forward by a piece of wire or string, through a hole made at the corner. By this arrangement the plate is instantly exposed to the lenses, and will be found admirably adapted for taking moving objects. It saves the trouble of shifting the ground glass frame for the plate-holder, and the consequent risk of moving the camera, so annoying in the old plan. The plate is also exactly the same distance from the lenses as the plate. For a camera not achromatic, the ground part of the glass may be placed outwards, so that the plate will he the thickness of the glass nearer the lenses than the image seen on the ground glass, and consequently nearer or in the chemical ray.

April 24.

John Burn Murdoch, Esq., F.R.S.E., Vice-President, in the Chair.

1. On the value of Gases from different Coals, and the price of Light in different places; also on a new mode of estimating the Consumpt of Gases, &c. &c., and of estimating Illuminating Power. By Andrew Fyfe, M.D., F.R.S.E., F.R.S.S.A., Professor of Chemistry, &c., King's College, Aberdeen. Illustrated by apparatus.

The first part of this paper referred to the illuminating power and durability of gases obtained from English caking coal, from English parrot coal, and from Scottish parrot coal, and with which gases the towns in England and Scotland are supplied, and consequently to the value of these gases for affording light. Taking the illuminating power, and the durability, and consequently also the values of the gas from English caking coal, with which Newcastle and many other towns in England are supplied, as the unit of comparison, Dr. Fyfe stated, that he found the illuminating power of the gas from the English parrot coal, such as that from Yorkshire and Lancashire, to he, on an average of numerous trials, 1.73, the durability to be 1.12, and hence the value, bulk for bulk, as 1.85. The value of gas from the different kinds of Scottish parrot coal varies considerably, according to the place from which the coal is obtained; but, as in the larger towns in Scotland, a mixture of coals of different quality is employed, the gas in these towns is generally very nearly of the same quality. Taking the average of all the trials made at Edinburgh, Glasgow, Greenock, Dundee, and Aberdeen, the illuminating power was found to be 3.23, the durability 1.58; thus making the value very nearly 5, compared with the English caking coal gas as 1, and 2.7 to the English parrot coal gas as 1; in other words, to light an apartment to the same extent, and for the same time, hy similar methods of consumption, the quantity of gas from Scottish parrot coal required, being as 1, the quantity of gas from English parrot coal would be more than double, and that from English caking coal would be five times as great. Dr. Fyfe then alluded to

the value of these different kinds of coal for affording gas, and consequently for affording light by the combustion of their gases. In ascertaining this, the quantity of gas given off from the coals, is taken into account, along with the value of the gases themselves for affording light. In this way he has fixed the value of the coals as follows:—English caking coal being 1; that of the English parrot coal is on an average 2.3; and that of the mixture of Scottish parrot coal, as used in different towns, as 6. In the second part of the paper Dr. Fyfe alluded to the methods of finding the value of coal gas, for the purpose of illumination, and more particularly to a new mode of determining the durability; in other words, the time required for consuming a certain volume of gas, and consequently the consumpt in given times, and by means of which, also, the specific gravity of the gas could be ascertained. From numerous experiments which he had performed, he had come to the conclusion, that when coal gases are burned from the same burner, with the same height of flame, the consumpt is as the square roots of the pressure necessary to keep up the combustion, at the length of flame fixed on; and that, consequently, the time required for the consumpt of equal volumes is inversely as the square roots of the pressure. He had also come to the conclusion, that the durability, in other words the time required for the consumpt, depends on the specific gravity, and that the same law is applicable; consequently, the specific gravity being known, the consumpt can be determined; as the consumpt being determined, by the pressure, the specific gravity can be ascertained, the rule being, the specific gravity is inversely as the square roots of the pressures, necessary to keep the gases burning, from similar burners, at the same height of flame. Dr. Fyfe stated, that he had put these different rules to the test of experiment with gases which he had prepared from different coals, and also with the gases found in different towns, and he exhibited numerous tables, showing the very close correspondence between the results obtained experimentally, and by calculation. He then exhibited an instrument by which the durability and specific gravity could, by the rates stated, be determined. It consists of a jet burner, of the 40th of an inch in diameter, to which is adapted a scale for measuring the height of flame, and a pressure guage for ascertaining the pressure under which the gas is burning, at the length of flame fixed on. In this pressure guage is fitted a graduated scale, with a burner, by which the pressure can be read off to $\frac{1}{100}$ of an inch. Along with this a table was given, showing the consumpt of gases in a given time—the time required for the consumpt of equal quantities, and the specific gravities, according to the pressures indicated by the guage. In the table the pressures ranged from $\frac{60}{100}$ to $\frac{200}{100}$ of an inch, which embraces all the pressures likely to occur with the jet-burner stated. Dr. Fyfe, in conclusion, alluded to a photometer, which, so far as he was aware, is not noticed in any publication, and which, he believed, was the invention of Professor Bunsen. It consists of a paper screen besmeared with a solution of spermaceti in oil of naphtha, excepting at a part around the centre. A candle placed behind this, transmits light in such a way as to make the part uncovered easily observed, when another light is placed in front of the screen, at a certain distance; according to the intensity of the light the spot disappears, and the paper becomes uniformly of the same appearance. In using other lights, the distance at which the uniformity on the surface of the screen is occasioned, depends on the intensity of the light; and thus, according to the usual law, the illuminating power of different lights is determined by the square of the distances at which they are situated from the screen. Dr. Fyfe stated that he had put this method to the test of experiment, and found it extremely accurate, and much more easily managed than the shadow test. He exhibited the screen in connection with the pressure guage burners, already described, by the use of which, the illuminating power, the durability, and the specific gravity of coal gases are very easily and quietly determined: and hence the value of an instrument of this kind to those travelling from place to place, with the view of ascertaining the value of coal gas in different towns, and of ascertaining the value of different kinds of coal for affording gas, and consequently for affording light by the combustion of their gases.

2. On the Composite Ellipse, as an element in the useful and ornamental arts,—being the second of a series of short papers upon the Harmony of Form. By Mr. D. R. Hay, F.R.S.S.A., 90 George Street. Illustrated by Diagrams.

Mr. Hay said that the paper and illustrations he now brought before the Society would show that the Composite Ellipse, as he described and arranged it, was an important element in the useful and ornamental arts. He then explained the relation which his Composite Ellipse bore to the Circle and to the regular Ellipse; also his mode of describing it, with an analysis of its composition. For this purpose he exhibited six large diagrams. He then went on to show that its beauty consisted in the variety of its parts being in an equal ratio to their uniformity; and that it was to regulate and classify the various developments of this variety, that he had in his work on "First Principles of Symmetrical Beauty," classified a series of forty-two of those figures, by an application of the laws of numerical ratio.

Mr. Hay then stated that he had brought the same subject before the Society about three years ago, as calculated to improve the practice of various arts; and that as it bore upon the humblest productions of the potter's art, the mechanic and the cottager might have, without additional coast, household utensils of forms as beautiful as the finest specimens of the antique.

Mr. Hay then observed that it had lately been stated in the Society that his Composite Ellipse had not novelty to recommend it, but had long been familiar to every one who had given any attention to the subject; and that Nicholson's dictionary of architecture had been referred to in corroboration of this statement. Mr. Hay, however, stated that neither the Composite Ellipse, his method of describing it, nor its application to the drawing of vases, was published in Nicholson's dictionary of architecture, or elsewhere, before he exhibited them to the Society, as just stated. In corroboration of which he read an extract from a letter which he had, on Saturday last, received from the Secretary of the London Society of Arts,—the transactions of which, he observed, were that night laid on the table.

3. Description of a new Ball Stop-cock for Water Cisterns, and of a Nose-cock for Casks or Vats. By Mr. Daniel Erskine, F.R.S.S.A., Plumber and Gas-fitter, Edinburgh.

The new Ball-cock consists of two flat surfaces ground air-tight, having port-holes for the water when in certain positions, and furnished with a spiral spring, that keeps the surfaces in contact. This spring is screwed down to the pressure of the water that it is fitted for, and as the water tends to lift it off the face, this gives it slight friction on either side, and it is not so liable to get fixed as the present ball-cocks are. The same kind will be of great advantage for gas-works, distilleries, and breweries, where large nose-cocks are required, and will be much less expensive.

4. Descriptions of a Model of a Stop-cock for Corrosive Fluids. By Mr. James Robb, Haddington.

This stop-cock is intended to obviate that tendency to stick fast, when the plugs of all the common kind have, especially when the fluids are of a corrosive or drying nature, such as common gas; and as it will have no tendency to leak, it may be employed with advantage in oil, beer, or water casks.

Its principal peculiarity consists in using vulcanized India rubber tubing, connected with the pipe by screw couplings, and compressed by means of a screw, as in the model, or otherwise, to any extent required, by which the flow of gas, or other fluid, may be regulated at pleasure.

The model is simple in its construction, being adapted for placing on the inlet pipe of a gas meter. But it may be made of any form, either plain or ornamental, besides being cheaper for large sizes, and easier repaired than those used at present.

May 8.

John Cay, Esq., Vice-President, in the Chair.

The following communications were made:—

1. On the properties of Zinc in Powder as applied to Agriculture; and also for the Preservation of Iron, Wood, Animal Substances, Public Health, &c. By Mr. James Scouller, 17 Turner's Court, Glasgow.

In the course of some experiments the author found that the metal zinc pulverized to a fine powder, and sprinkled on land prepared for sowing, had a beneficial effect on vegetation, and in the destruction of noxious vermin. He also found that iron-work of any magnitude may be preserved from oxidation by coating it with this powder and varnish; and that wood-work can be preserved in like manner. That cloth prepared after the style of glass-paper or sand-paper, makes an excellent wrapper for polished steel articles exposed to wet or damp; and that, from its strong affinity for chlorine, it has the effect of keeping noxious gases from forming, thereby preserving animal bodies covered with it, from putrefaction, and that hence it might be used with good effect in sprinkling confined places, such as in ships.

The author suggests that a solution of zinc and muriatic acid, forming a chloride of zinc, might be used with benefit in hospitals for contagious diseases, by saturating cloth, and hanging it extensively in the room; this fluid, being an absorbent, would cause a constant, yet gentle, current of air, besides destroying malaria. The author stated that a portion of this fluid (as one in eight) mixed with alum and water—say eight gallons—kept in a leaden cistern attached to a fire-engine, and allowed to mix with the water intended to extinguish the fire, would at first go a great way to keep the flames from spreading.

2. Description and Drawing of a method of Preventing Accidents at Pits from the breaking of the Rope, or from its being drawn over the Pit-head pulley. By Mr. William Alexander, Mining-Engineer, Summerlee Iron-Works, near Glasgow.

The author stated that the accidents common to mineral working, so far as connected with the machinery, are generally fatal, and under two distinct heads. First, the breaking of the winding rope; and, second, the continuous movement of the engine, either from neglect or otherwise, so that the cage is drawn over the pit-head pulley. To obviate the first, he applies a simple method of checking the descent of the cage; and the second, by winding entirely by friction, which is removed by self-action at a fixed point. Besides these very desirable ends being obtained, the machinery will be found much simplified and cheaper.

3. Suggestions as to the possibility of a more extended application of Electrical Combinations to Mechanical and Domestic purposes. By Grant S. Dalrymple, Esq., Civil Engineer, Edinburgh.

Illustrative Galvanic Apparatus was exhibited in action.

After a brief outline of the rapid progress which the science of Electricity has made during the last half century; and, owing to which development, it is now worthy of being ranked amongst the foremost of the sciences embraced under Natural Philosophy—the writer stated that the great hinderance to a more speedy application of the science to practical purposes, is the extreme subtilty of the fluid; the rapidity of its movements being such as to defy the keenest observation.

The great problem to be solved is, how to obtain the greatest effects from the least exciting surfaces, or battery. The author considered that, by a proper attention to the subject of what is called Induced Electricity, as in the case of primary and secondary coils, where, the moment the progress of the current through the primary wire is broken, a still more violent shock is experienced in the secondary coil, very important results would be arrived at. It would be interesting if formulæ could be laid down for determining the intensity of the current generated in the secondary wire, supposing it to be a certain number of times the length of the primary one. Thus, let $a =$ length of primary wire, and let the secondary wire be n times the length of the primary, or $= na$. Let f be the force of the current generated in the primary coil, and let x be the force which is to be determined in the secondary coil, then will $x = \frac{naf}{a} = nf$ be the proper formula.

Small apparatus were exhibited, showing how this held good in some cases.

The author also suggested that Galvanic Electricity will, ere long, be employed

for lighting our streets in place of gas. By this means all the lamps of a town may be simultaneously lighted at a certain hour. The application of the same science to the culture of the soil is also practicable. Although it had not yet succeeded, that was no proof of its inapplicability to the purpose.

The paper concluded by begging the members of the Society to devote some attention to the subject, as affording a fine field for extended usefulness; and it summed up with an extract from the Eleventh Series of Faraday's "Experimental Researches in Electricity," showing the importance which that great master of science attached to the subject.

Thanks were voted to Mr. Dalrymple for his communication, and to Mr. Kemp, who, in his absence, kindly undertook to exhibit the galvanic apparatus in illustration of the paper.

4. Description of a new Machine or Pump for lifting water, possessing many advantages over the common pump, both by sea and land. By Mr. John M'Dowall, Engineer, Johnstone.

An elegant working model of full size was exhibited in action. The properties of the screw pump, as stated by the inventor, are as follows, viz.: 1st, It can be constructed almost of any material, such as cast iron, malleable iron, brass, copper, tin, lead, or wood. 2d, There is no limit to the height to which it will raise water: it only requires the chamber and upright spindle to be made as high as the head to which the water is to be raised. 3d, It has many advantages over the common pump, such as in the case of draining meadows, quarries, coffer dams; and, in particular, for ship pumps, as it has no valves or packing of any description, consequently cannot be choked by grain, mud, sand, or any such substance. 4th, It is adapted to lift mud as well as water, and having no rubbing surface on any parts, except the bearings of the upright spindle, it is not in the least liable to get out of order.

The inventor states that he has constructed a pump of this kind at Barr Loch, the property of Col. M'Dowall of Garthland, near Lochwinnoch, for draining the meadow. The chamber or barrel is 26 inches in diameter. When in full operation, he fully expects that it will raise 400 cubic feet of water per minute. The machine is driven by a water wheel, and is altogether very simple.

ENGLISH PATENTS.

Sealed from 26th May, 1848, to 13th June, 1848.

Abraham Solomons, London, merchant, and Bondy Azuley, Rotherhithe, Surrey, printer,—"Improvements in the manufacture of gas, tar, charcoal, and certain acids."—May 26th.

Matthew Hague, Waterhead Mills, Lancashire, machine maker, and Joseph Firth, Huddersfield, Yorkshire, cotton doubler,—"Certain improvements in machinery for twisting and doubling cotton yarns and other fibrous materials."—26th.

Moses Poole, London, gentleman,—"Improvements in propelling vessels."—(Communication.)—26th.

James Parker Percy, Clarendon-place, Notting Hill, gentleman,—"Certain improvements in obtaining copper from copper ores."—26th.

James Remington, Warkworth, Northumberland, civil engineer,—"Improvements in locomotive engines, and in marine and stationary engines."—26th.

Thomas Richardson, Newcastle-upon-Tyne, chemist,—"Improvements in the manufacture of manure."—26th.

Felix Hyacinthe Folliet Louis, Southwark, Surrey, gentleman,—"An improved method or process of preserving certain animal products."—26th.

William Wood, Cranmer-place, Waterloo-road, Surrey, carpet manufacturer,—"Improvements in weaving carpets and in printing carpets and other fabrics."—30th.

William Seaton, Camden Town, Middlesex, gentleman,—"Improvements in closing tubes and in preventing and removing the incrustation in boilers."—30th.

William James Barsham, Stratford, Essex,—"Improvements in the manufacture of mats."—June 1st.

Thomas Hunt Barber, King-street, Cheapside,—"Improvements in machinery for sawing wood."—1st.

Richard Christopher Mansell, Grange-road, Surrey, gentleman,—"Certain improvements in the construction of vehicles used on railways or on common roads."—1st.

Thomas Burdell Turton, Sheffield,—"Certain improvements in machinery for bending and fitting plates or bars of steel, iron, and other materials, to be used for locomotive engine and carriage springs and other purposes."—1st.

Joseph Wheeler Rogers, Nottingham-street, Dublin,—"Certain improved methods and machinery for the preparation of peat as a fuel, and in the combination of certain substances as a compost or manure."—1st.

Henry Adcock, Moorgate-street, London, civil engineer,—"Certain improvements in furnaces and fire-places."—3d.

William Brindley, Birmingham, manufacturer,—"Improvements in the manufacture of articles of papier-mache."—6th.

Richard Barnes, Wigan, Lancashire, gas engineer,—"Certain improved apparatus for manufacturing gas for illumination, part of which improvements is applicable to retorts for distilling pyroligneous acid and other similar purposes."—6th.

Benjamin Lathrop, King-street, Cheapside, Esq.—"An improved wheel for railway purposes."—(Partly a communication.)—6th.

Joseph Foot, Spital-square, Middlesex, silk manufacturer,—"Improvements in marking skeins of silk."—(Communication.)—8th.

Joshua Procter Westhead, Manchester,—"Manufacturing fur into fabrics."—(Communication.)—8th.

Thomas Dalton, Coventry, silk dyer,—"Improvements in the manufacture of fringes, gimps, and bullions."—8th.

Alexander Paul Maril Darlin, Paris, France, gentleman,—"Improvements in obtaining motive power."—8th.

Richard Want and George Vernum, Enfield, Middlesex, engineers,—"An improved steam-engine, which may be also worked by air and other fluids."—10th.

John Miller, Henrietta-street, Covent-garden, London, gentleman,—"A new system of accelerated menattrite locomotion, even by animal expulsion, for every species of transport machines acting by means of wheels, whether on land or water."—13th.

Charles Henry Capper, Edgbaston, Warwick, gentleman,—"A method of preparing and cleaning minerals and other substances."—13th.

Joshua Taylor Beale, East Greenwich, Kent, civil engineer,—"Improvements in the construction and arrangement of engines and machinery for propelling boats or vessels on water, with a means of preventing incrustation in the boilers, parts of which improvements are applicable to land purposes."—13th.

William Hunt, Dodder-hill, Worcester, chemist,—"Improved apparatus to be used in processes connected with the manufacture of certain metals and salts."—13th.

Sir Henry Hart, Commissioner of Greenwich Hospital, Rear-Admiral in our Navy,—"Improvements in apparatus for preventing what are called smoky chimneys."—13th.

William Chamberlain, jun., St. Leonards-on-the-Sea, Sussex,—"Improvements in apparatus for recording votes at elections."—13th.

James Roose, Darlaston, Staffordshire, tube-manufacturer, and William Haden Richardson, the younger,—"Improvements in the manufacture of tubing."—13th.

SCOTCH PATENTS.

Sealed from 24th May, 1848, to 16th June, 1848.

Thomas Hunt Barber, King-street, Cheapside, London,—"Improvements in machinery for sawing wood."—(Communication.)—24th May.

Edmund Barber, Tring, Herts, decorative painter,—"Certain improvements in graining and decorating in oil, distemper, and other colours, and in imitating marbles, granites, fancy, and other woods, and in the apparatus and instruments to be used therein."—26th.

George Henry Bachhoffner, Royal Polytechnic Institution, London, Doctor of Philosophy, and Professor of Natural Philosophy,—"Improved means of transmitting, communicating, or conveying intelligence."—31st.

Lewis Dunbar Brodie Gordon, Abiugdon-street, Westminster, civil engineer,—"An improvement or improvements in railways."—7th June.

Benjamin Lathorp, 7 King-street, Cheapside, London, Esq.—"An improved wheel for railway purposes."—(Partly his own and partly a communication.)—7th.

William Roche, Dudley, Worcestershire, engineer,—"A new mode of treating and applying wrought iron."—12th.

George Philbrick Swinborne, Pimlico, Middlesex, gentleman,—"Certain improvements in the manufacture of gelatinous substances."—16th.

Edward Brown, Adam's-court, London, gentleman,—"Certain carbonic compounds formed of earth, vegetable, animal, and mineral rubbish, fecal substances, the waste of manufactories, and certain acids and alkalies, which compounds are applicable as manures."—(Communication.)—16th.

IRISH PATENTS.

Sealed from 20th May, 1848, to 20th June, 1848.

George Philbrick Swinborne, Pimlico,—"Certain improvements in the manufacture of gelatinous substances."—5th June.

Jasper Wheeler Rogers, Nottingham-street, Dublin, civil engineer,—"Certain improved methods and machinery for the preparation of peat as a fuel, and in combination with certain substances as a compost or manure."—12th June.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from May 20th, 1848, to June 14th, 1848.

May 20th, No.	1453.	Richard Stratton, Bristol,—"Water cart."
22d,	1454.	Francis Wishaw, C.E., Gray's Inn-square, London,—"Wishaw's Telekouphenon, or pneumatic telegraph."
23d,	1455.	Thomas Powell, Birmingham,—"Blind pulley."
25th,	1456.	Edward George Barton, Lambeth, and Joseph Clowes, Esq., Camberwell,—"The universal gas-meter."
—	1457.	George Howe, Great Guilford-street, Southwark,—"Steam-boiler water guage."
29th,	1458.	John Tongue, Parade, Birmingham,—"Brooch fastener."
30th,	1459.	William Bonser, Kinolton, Nottinghamshire,—"Drain pipe."
—	1460.	Michael Scott, Liverpool Corporation Water-works, Liverpool,—"Design for a water-cock, intended principally as a hydraut for watering streets, supplying shipping, fires," &c.
—	1461.	George Simpson, Glasgow,—"Safety winding and detaching catch for mine shafts."
—	1462.	William Webb and William Greenway, Birmingham,—"Knob cupboard-turn."
31st,	1463.	John Brayton, Crookholm-mill, Sebergham, Cumberland,—"Millstone."
June 2d,	1464.	Rock and Son, Hastings,—"Carriage head."
—	1465.	William Southam, Nuneaton, Warwickshire,—"Pneumatic flour dresser."
—	1466.	John Eaton, Woodford, near Thrapston, Northamptonshire,—"Tipping cast."
6th,	1467.	William Bonser, Kinolton, Nottinghamshire,—"A drain pipe."
7th,	1468.	Ephraim Ferdinand Wollheim, Paris,—"Comb tooth cleaner."
8th,	1469.	Joseph Sayce, Cornhill,—"Easy morning coat (the Toina)."
9th,	1470.	George Lander, Cheltenham,—"Dress-extending zephyr belt."
10th,	1471.	Alexander Hett, Leicester-square, London,—"Water valve."
—	1472.	Robert M'Clay, Liverpool,—"Refrigerator."
14th,	1473.	John Randolph Remington, Stafford,—"Farmers' and graziers' portable mill."
—	1474.	Richard Garrett, Saxmundham,—"Thrashing machine."

TO READERS AND CORRESPONDENTS.

Books Received—"Wilder on Steam Boiler Explosions;" "Electrical Condition applied to Facts."

M. Scott.—We are obliged by his polite note, and shall feel happy in hearing further from him.

Constant Reader, Whitehaven.—His bookseller should be able to furnish the information. We will see if we can find anything to suit him.

C. J., Birmingham.—A list of the registrations of ornamental designs would require a large volume itself; indeed we do not see how such a list could be furnished at all, if the designs were to be described. Nearly 100,000 have been entered since the commencement of the working of the Act.

John, Birmingham.—As far as we can understand the sketch sent, his boiler is identical with the sheet water space boiler invented by Mr. Johnstone of Greenock. The plan referred to has never yet received an actual practical working test; therefore we are not prepared to say how far it is advantageous. Perhaps we do not understand the sketch aright. Will he forward us another?

Thos. Miller, London.—His plan of stop-catch appears, from his description, to be good; but we do not see any practical objection to the one we have published, as the guides are well stayed. Perhaps he will, at some future period, favour us with a drawing of it.

An Intending Patentee should address his queries to the Patent and Designs Office, 33 Buchanan-street.

Jacta.—We regret that want of space prevents our notice of his communication this month.

J. H., London.—The article has not been patented here.

Design.—Novelties of the kind he mentions are always welcome.

A. Silcock.—If he studies the two articles throughout, he will be best able to judge for himself as to the proportions of the fan. After comparing all the circumstances of the case, he may see how far the proportions in the second paper will suit him. To go over the whole, and apply it to his peculiar case, would cost us some time.

J. Walters.—We are anxious to oblige him, but really think the matter has already been set forth as plainly as possible.

☞ A number of letters and notices must lay over for want of room. We hope to keep a-head of them in future.

CRANK CUTTING MACHINE.

Plate XI. *Vol. I.*

Fig. 1.

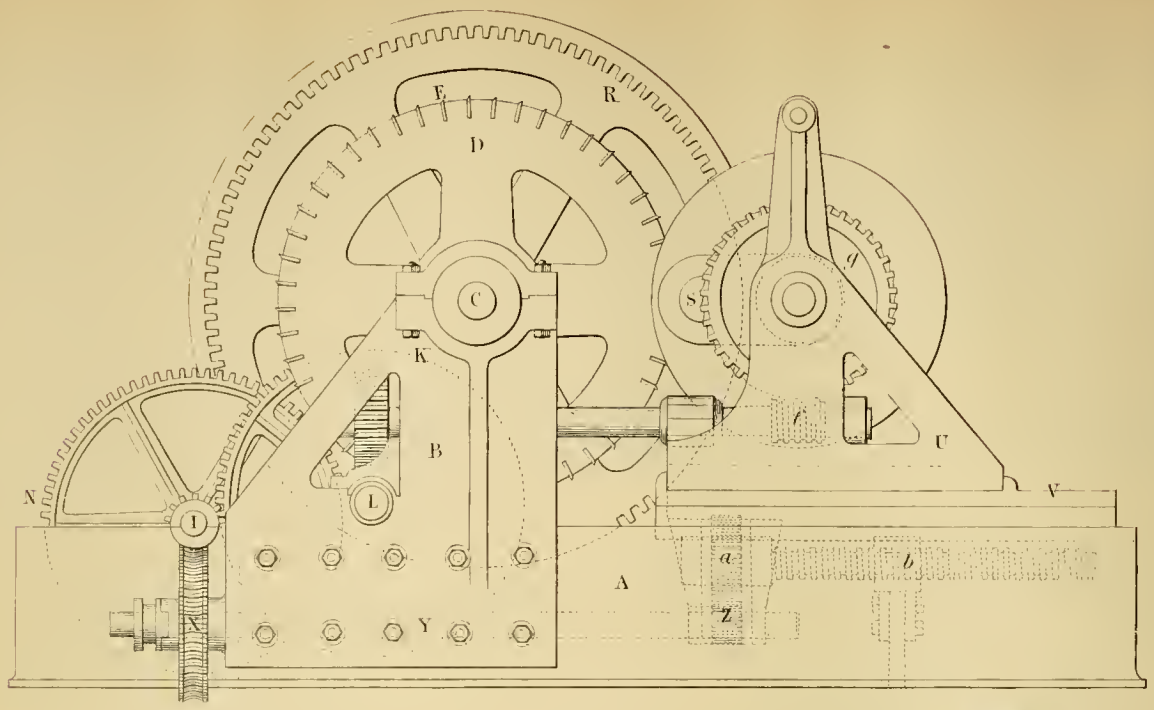
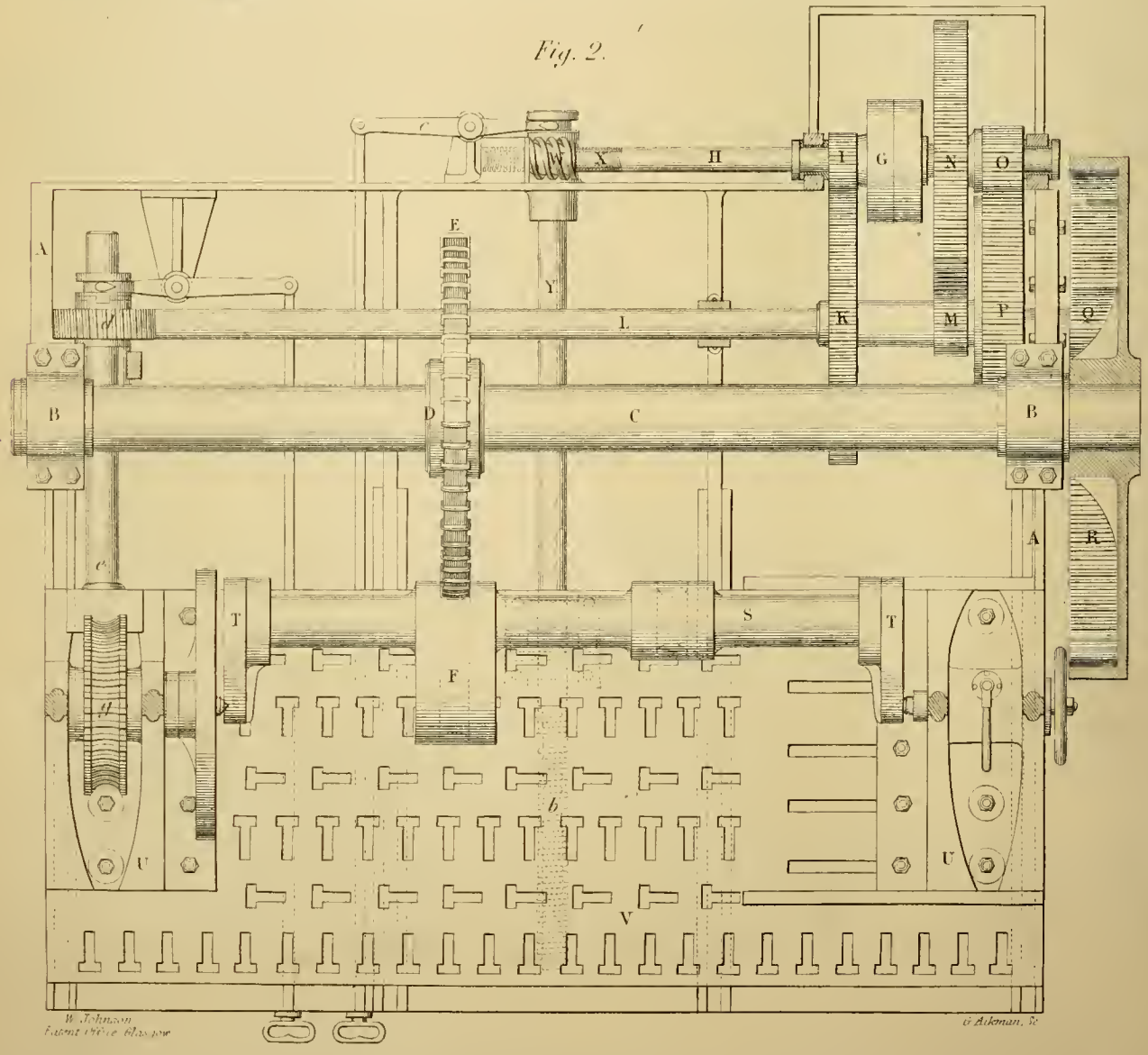


Fig. 2.



Scale

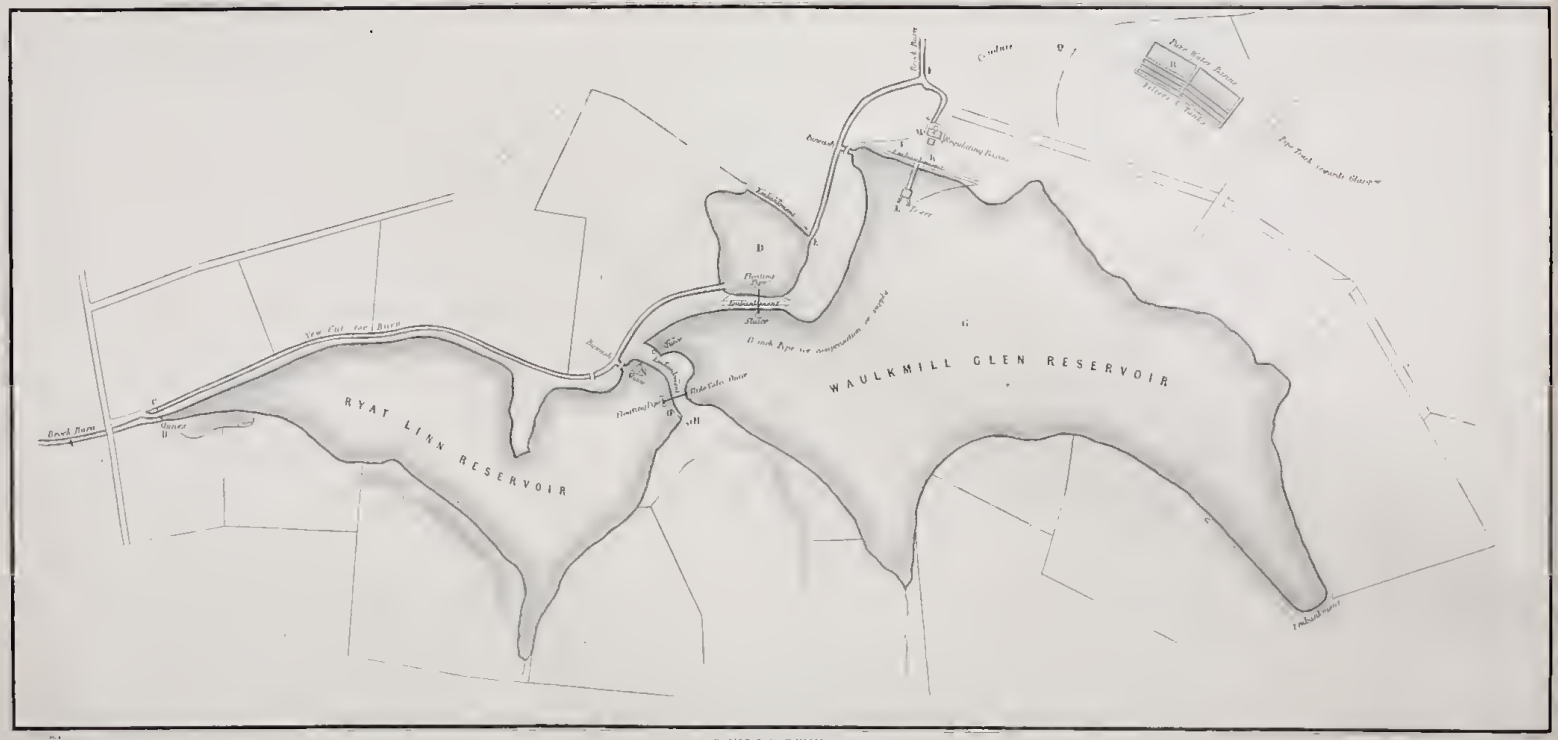
12 9 6 3 0 1 2 3 4 5 10 Feet

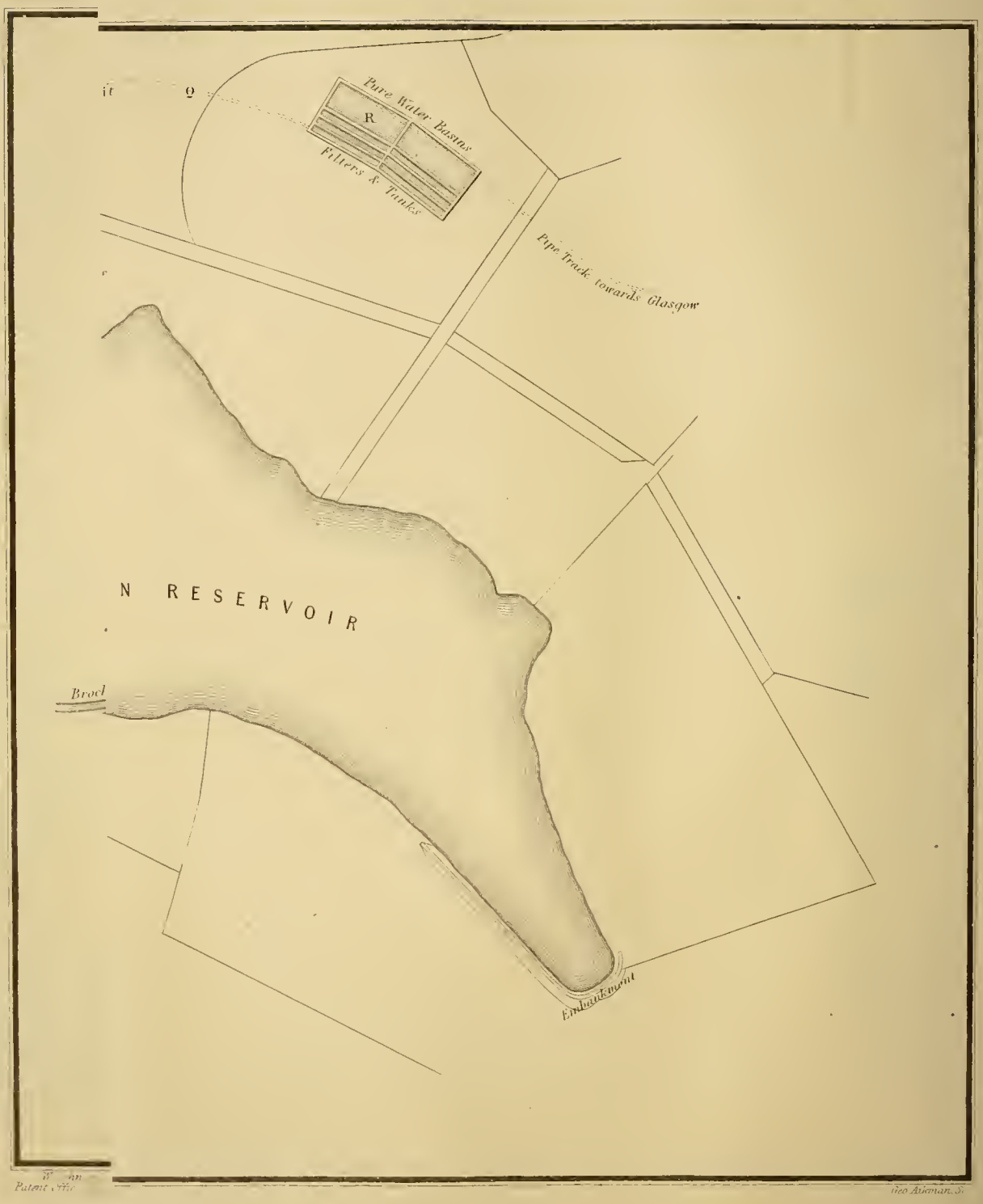
Plate V

CORBALS GRAVITATION WATER WORKS.

GENERAL PLAN.

Vol I


RYAT LINN RESERVOIR
WAULKMILL GLEN RESERVOIR
Pure Water Basins
Pure Water Pipe
Pure Water Pipe
Pure Water Pipe


Pure Water Basins
R
Filters & Tanks
Pipe Track towards Glasgow
N RESERVOIR
Brool
Embankment

PRACTICAL NOTES.

WATER SUPPLY OF LARGE TOWNS.—THE GORBALS GRAVITATION WATER WORKS.

Illustrated by Plates 10.

An Eastern tradition, whose quaint language adds point to the moral which it inculcates, sets forth that a native physician, travelling in search of a locality suited by disease for his labours, on entering the gates of a strange city, and beholding the citizens' baths, exclaimed, "All baths here—this is no place for me." Bending his steps onwards, the same features of health and cleanliness met his eye in several neighbouring towns, and his heart sank within him at the seeming scarcity of employment. He again essayed his inquiries at a more distant city, and found no baths. "This is the place for me," he observed; "no baths—plenty of ague and unhealthiness;" and he entered and took up his abode therein. What a lesson do we derive from this simple story! How the man of medicine would rub his hands and chuckle at the sight of any one of our modern cities, where baths exist not, and where the supply of water for the pure necessities of life is meagre, and its quality bad.

With the growth of modern engineering science, and the extension of the practice of the philosophical principles of construction and arrangement, it is remarkable that, in many respects, we have never arrived at the perfection attained by the ancients. The remains of their magnificent aqueducts at once attest their foresight in obtaining for themselves an abundant water supply, and their genius and perseverance in the construction of their works.

The water works of this country differ essentially from the ancient Roman or the more modern French works, if we except the metropolitan New River scheme, and the later example of the Peak Forest Canal, in both of which the water is led along an open course. The New River receives its supply of water from various springs in Hertfordshire, about 20 miles from London. These springs, together with the water of the river Lea, are collected into a large open basin, whence, by a cut of 40 miles, falling three inches per mile, they are conducted to a series of brick cisterns, from which the mains for the supply of the streets radiate. The Peak Forest scheme, to which reference is made in another part of these pages, is nothing more than a canal out of employment as a highway for goods, which has been put to a good use in affording a water supply for Manchester. The Croton aqueduct of New York is by far the most gigantic scheme of the day. This aqueduct is supplied from the Croton river, which rises in the county of Putnam, fifty miles from New York. It is 38 miles long, arched over throughout; and at the point where it meets the river, the latter is dammed back, throwing back the current about six miles, so as to form an immense reservoir. The whole works cost about two and a-half millions. In the bulk of instances, the towns in this kingdom are supplied either by pumping from wells or reservoirs, or by leading off water from elevated situations through cast-iron pipes. The Gorbals Gravitation Works, as their title implies, are constructed upon the latter system; but, before entering into their details, let us glance at the past history of the water supply of Glasgow.

Previous to the year 1755, when Glasgow existed as a mere nucleus of its present bulk and splendour, its population being no more than 23,000, water was obtained in the primitive manner of the olden time, from wells and chance streams, and in pailfuls from the Clyde. Hydraulic engineering had not then a name, for the requirements of the time were few and simple; the good folks dreamed not of "water rates," as, being content with an unsystematic supply, they cared little for their personal trouble in procuring it. The gradual enlargement of the city led to the proposition of various schemes about the year 1780, when the inhabitants numbered 43,000. At this time the celebrated but unfortunate Henry Bell projected the formation of a canal, by which to draw off water from the Falls of Clyde; and a speculation was entered into by a Mr. Harley, who erected pumps at Willow Bank, and forced the water through pipes, into a reservoir in Upper Nile Street, whence it was carted through the town, producing a revenue of £4,000 per annum. It was not until the year 1806 that anything like a responsible company was formed, when Mr. Telford was called in to report on the plans then afloat. On his recommendation, two steam-engines were erected on the banks of the river at Dalmarnock, about two miles above the city, and 14 inch pipes were connected with a reservoir on the spot, which at that time bore the name of the Gallow Muir. At this date, the Clyde, then a mere streamlet, and guiltless of aught but herring wherries, was comparatively pure, and advantage was taken of the great bank, or peninsula of sand, round which it sweeps in the form of a horse shoe, for the formation of a natural filter, by driving tunnels along its borders. A well of 10 feet diameter, reaching 12 feet below the ordinary surface of the river, received the water which percolated through the sand into the tunnels, whence it was conveyed across the bottom of the river to the city side, where the pumping engines were placed, by the noted spherical-jointed pipes suggested by Watt. As the inhabitants increased in number, and manufactories congregated closer together, the river became more and more polluted: and the matter, considered in a sanitary point of view, at length became a subject of the deepest consideration to the community at large. In low states of the river, the water was frequently sent into the city without any filtration whatever; and the result has been, that the inhabitants for years back have been supplied with a muddy liquid, and, if we are to rely upon the Parliamentary evidence as to the inadequacy of this company's resources, occasionally containing eels and varieties of small animals.

That such a state of matters should have existed so long in Glasgow, which, as the main portion of our paper will show, is by no means without the pale of a good water supply, is a matter of great surprise, considering the energetic measures adopted by the directing heads of the city in reference to the navigable capabilities of the river, and the perseverance with which they have carried on various other public schemes. It remained for that portion of the inhabitants resident in the large suburb of Gorbals, on the south side of the river, to attempt the amelioration of the evil; and accordingly a joint-stock company was formed by them in 1845, under the name of the Gorbals Gravitation Water Works Company, Robert Bunten, Esq., being elected chairman; Andrew Gemmill, Esq., secretary; and William Gale, Esq., engineer to the company.

With a view to a judicious selection of water, the engineer made a preliminary survey of the country to the south and west of Glasgow, and examined the Harelaw reservoir of the Paisley Water Company, to ascertain how far this source, aided by additional artificial drainage, might be relied on in point of quantity. The level of this reservoir is about 530 feet above the Broomielaw quay, and by raising the present embankment to a height of 44 feet, its capacity might be more than doubled; but from the limited extent of surface drainage, and the isolated position of the hill upon which it is formed, precluding the leading into it of any additional supplies, the idea of making use of it was abandoned, as unsuited for the Gorbals population of 60,000, with a large annual increase.

After a careful survey of the country within an available distance of Gorbals, the present site on the Brockburn was recommended by the engineer, and its water was subjected to separate chemical analyses by Professor Thomson of Glasgow University, Professor Gregory of Edinburgh, and Professor Penny of the Andersonian University. The result of these experiments showed the water to be remarkably pure, and excellently suited for domestic purposes, containing, as Professor Gregory states, only one-ten-thousandth part of its weight of solid matter. Acting upon this satisfactory evidence, the necessary Parliamentary plans and sections were prepared, and after a severe contest with the Glasgow Water Works Company, the Gorbals Gravitation Company's bill received the Royal assent on the 3d of August, 1846, and on the 8th of March, 1847, the directors of the undertaking cut the first sod. On a late visit

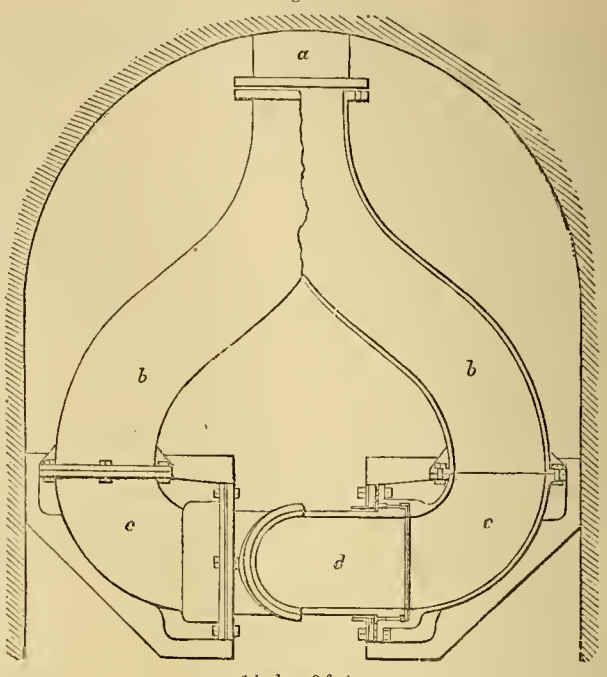
of inspection to the works, over which, in the absence of Mr. Chalmers, the resident superintendent, we were politely conducted by Mr. Samuel Baird, we found them picturesquely situated in the Patterton Braes, between the manufacturing village of Barrhead and the hamlet of Mearns, being about 1½ miles distant from each place, and about 5 miles in a direct line from Glasgow. Plate 10 represents the plan of the entire works, from the first impounding of the stream to the delivery pipes from the filters. The chief feeding stream, the Brock, marked A on the plan, takes its rise to the westward of the Brother Loch, and runs in a northerly direction until it joins the Walton Burn in the Cauldcots farm, near Craigton. The source of the Walton is to the north of the Long Loch, and the united streams proceed by Fingleton mill and Balgray House, crossing the Barrhead road at Partontoes, and thence stretching to the west of Upper Pollock House, the seat of Sir Hew Crawford, near which the works are situated. From this point, the course of the stream is by Darnley bleachfield, now in ruins; thence to Darnley corn-mill, intersecting the road near Darnley toll; passing Cowglen, and continuing in a north-west direction, it receives the Laveron near Haugh Bridge, and the combined streams, sweeping close to Cruikstone Castle, fall into the Cart near Cardonald mills.

The amount of surface which drains into the Brock and its tributary the Walton, is about 3000 acres, and the average annual fall of rain, as indicated by rain-guages kept near the locality, is 55 inches; so that, allowing 36 inches as available for the supply of the reservoirs, the amount will be equal to a supply of 20 gallons per head per day for a population of 260,000, in addition to the compensation to mill-owners, whose water power has been interfered with by the impounding of the streams. The requisite reservoirs for the storage of the water have been constructed in a very simple manner, by throwing embankments across the stream at different points where the natural surface of the ground offered advantages for impounding the stream. The point where the works commence is at the extreme left of the plate, where the Brock is represented at A, passing beneath the Barrhead road. A range of sluices are placed at B, commanding the entrance into the highest, or Ryat Linn reservoir, so that, when necessary, the stream, or any portion of it, may be diverted down its new course through the second range of sluices, C. This cut runs parallel with the Ryat Linn reservoir, and enters a second or intermediate reservoir, D, whence it issues at E, and is ultimately conducted to the original course of the stream at F, immediately below the third, or Waukmill Glen reservoir, G. The level of the Ryat Linn is about 300 feet above the Broomielaw quay, and its capacity is about 12,000,000 cubic feet, covering 30 acres of the Ryat farm. Owing to the natural capabilities of the ground, this reservoir has been formed at a very slight cost, the chief work being a 40 feet embankment at H, which is formed of clay puddle, beaten and consolidated, and pitched with stone on the side next the water.

The Waukmill Glen reservoir stands at an elevation of about 280 feet above the Broomielaw quay, and has a content of about 38,000,000 cubic feet, and covers an area of 40 acres, 22 of which are on the Patterton farm, belonging to Sir John Maxwell, and the remainder on the Ryat farm, the property of Sir Hew Crawford. It is formed almost entirely by a 55 feet embankment thrown across a chasm at I.

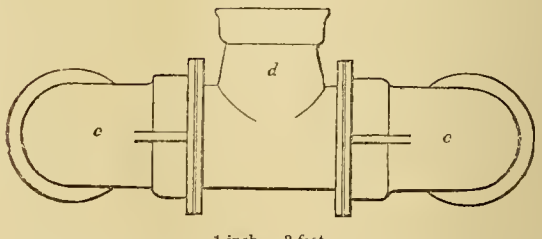
The Gorbals water is drawn entirely from the lowest reservoir, the Waukmill Glen, by a 2 feet pipe, K, leading from the base of an octagonal tower at L, through the embankment, I, into the self-regulating valve-house at M (see Plate 11). This tower is placed at about 120 feet from the edge of the embankment, access being had to its top, where the adjusting nuts of the stop-valves are placed, by a timber gangway, stretching from the embankment. The upper, or Ryat Linn reservoir is used entirely for the supply of compensation water for the mills below the site of the works, the water being drawn off by a 17 inch main, passing from the point N, where a stop-valve is placed, through the embankment and along the bottom of the lowest reservoir, opening into the self-regulating valve-house, side by side with the pipe K. Should it be necessary to draw off a supply from the Ryat Linn for the lower reservoir, it is taken through the 17 inch floating pipe, O, the lower end of which is jointed to a short fixed line of pipes passing through the embankment. The working joint of this pipe is represented in figs. 1 and 2 of our woodcuts.

Fig. 1.



1 inch = 3 feet.

Fig. 2.



1 inch = 3 feet

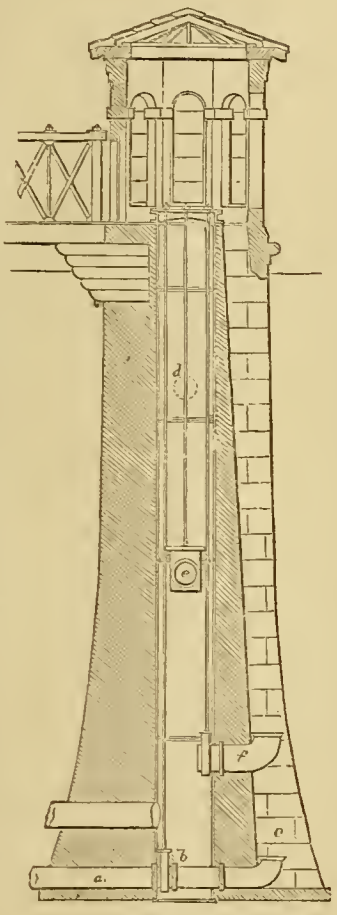
Fig. 1 is a plan of the end of the fixed main, as set in a recess cut in the side of the embankment. Fig. 2 is a front elevation of the same portion, showing the socket of the floating pipe fitted in its place. The end of the straight line of pipes is represented at *a*, just clear of the masonry of the embankment; to this is bolted the double-curved branch pipe, *b b*, one of which branches is shown in section. Each branch is continued by short elbow pipes, *c c*, with socket ends for the reception of the T socket end, *d*, of the floating pipe. This T piece is turned and faced on its ends to work freely on brass face-pieces in the sockets of the elbows, *c c*, into which it is secured by flange rings bolted on. The floating pipe is composed of sheet iron, covered with wooden sheeting, and is fitted into the socket, *e*, its contrary open extremity being supported near the surface of the water by two cylindrical sheet-iron floats, to which it is slung by a cross bar and chain. In this way the ingress extremity of the pipe is retained near the water level, wherever that may be, and thus the clearest water is carried off by it to the reservoir below.

Provision is also made for obtaining a supply from the upper reservoir, by the compensation main, ordinarily employed only for the feeding of the stream below the works. This is effected by the arrangement of stop-valves at N, one of which communicates with the bottom of an open upright receiving pipe for taking off the surface water, the other opening

directly into the bottom of the reservoir. Both valves are connected with a single spindle running up the side of the embankment, and fitted with an adjusting nut at its upper end, by means of which the water can be taken from the high or low level, according as it may be required for supply or compensation.

Fig. 3 is a sectional elevation of the valve tower, with the various receiving pipes for drawing off the water at different levels, to suit the height of water which may be in the reservoir. It is an octagonal building, tapering after the fashion of a lighthouse, from a base of 24 feet to 14 feet at the water level, immediately below the coping of the house, forming its apex. The pipe, *a*, passing diametrically through its base, is the one represented as branching from the compensation main in Plate 10; it is fitted with a stop-valve at *b*, and, passing through the masonry, it terminates in an open bell mouth, turned upwards, in the bottom of a recess, *c*, formed in the side of the masonry. Thus, when the valve, *b*, is opened, water may be taken from the lower reservoir, by the bell mouth in the recess, *c*, through the branch pipe, *a*, into the compensation main. A cylindrical well, 4 feet 6 inches in diameter, is formed throughout the centre of the tower, its upper end opening into the house at the top. This well is lined throughout with cast-iron cylinders, cast in lengths of five feet, and serving as a receiver for the clear supply water for the filters. Three distinct receiving pipes, *d*, *e*, and *f*, open into the well, and by these the clear water may be taken off at three several heights, in order to suit the level in the reservoir. Each pipe is fitted with a stop-valve in the interior of the well, up which the whole of their actuating rods pass to a cast-iron ring in the house, employed for carrying their adjusting nuts. In cases of emergency, the water may be shut off from any of these pipes, by plugs let down upon their bell mouths through the recesses in the sides of the tower, as also shown in the horizontal section of the tower, fig. 4.

Fig. 3.



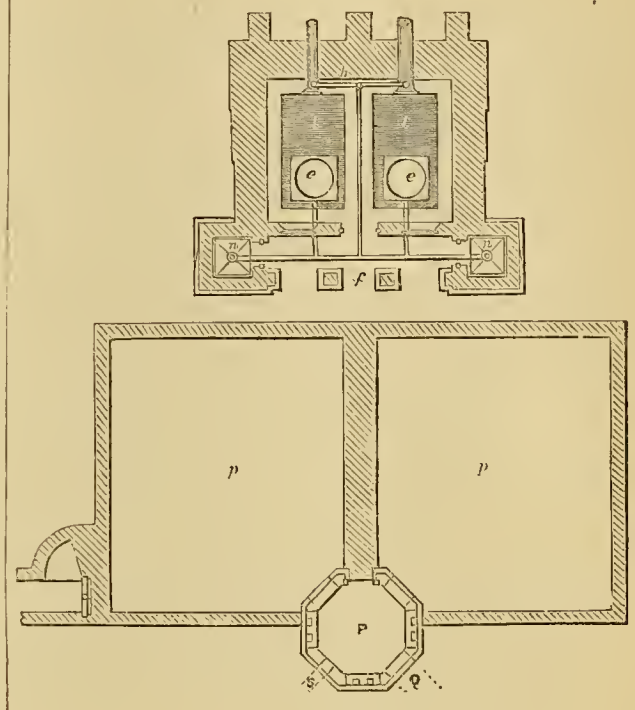
$\frac{3}{8}$ inch = 10 feet.

Fig 4.

$\frac{3}{8}$ inch = 10 feet.

The 24 inch supply, and 17 inch compensation pipes then pass side by side directly through the embankment, opening into small rectangular basins contained in the building, represented in vertical section in Plate 12, and in plan on a smaller scale in woodcut, fig. 5. Each pipe is fitted with a square mouth-piece, faced to receive a square hinged flap-valve, *a*, which is retained in any desired position by the bent lever, *b*, working loosely on a stud carried by two cast-iron brackets screwed to the extremity of the pipe. The lower end of this lever is fitted with a loose anti-friction pulley working upon the back of the valve, the contrary end being attached by a chain passing over a pulley at *c*, to a cast-iron float, *d*, working in the cylinder, *e*. The entrance to the house is by a central door at *f*, in a rusticated portico forming the front of the building; and

Fig. 5.



1 inch = 24 feet

in the recess at each end of the portico is placed a small closed cistern, *g*, supplied with water by a horizontal pipe in communication with the vertical pipe, *h*, placed on each main for the escape of the air. These cisterns are thus kept constantly supplied with water, and a communication is formed between them and the bottom of the cylinders, *e*, by pipes, *k*. The action of this apparatus is as follows:—Water being supplied to the cisterns, *g*, it enters the cylinders, *e*, and raises the floats. In this way, the chains attached to the actuating levers, *b*, are slackened, and the valves, *a*, open to admit of a greater discharge of water into the two small cisterns, *l*, the water from which then flows beneath four archways, forming the support of the building, one of them being drawn in section at *m*, in Plate 12. The discharge of water elevating the level of the water passing through the arches, the floats, *n*, resting upon it, are raised, and their spindles, being in connection with double beat valves in the vertical part of the pipes, *k*, at *o*, the upper or discharge valve of the cisterns, *g*, is closed, and the lower one, being simultaneously opened, the water which buoys up the float, *d*, in the cylinder, *e*, flows out, and the depression of the float closes or partially closes the valves, *a*, so as to preserve a perfect uniformity of supply and demand. This automatic arrangement, as we shall subsequently explain, is acted upon by the rising or falling of the water level in the filtered water tanks at the extremity of the conduit, Q, so that the supply to the filters themselves is accurately regulated.

The water then flows through the archways into two regulating basins, *p q*, whence it is discharged through sluices in the octagonal building, R, by the conduit, Q, leading to the filters, R, on one side, and by a short pipe in connection with the original course of the river at S, on the other.

We must defer further detail of the regulating basins to our next number, when plates and complete descriptions of the filters will be presented.

THE THEATRES AND PORTICOES OF ANCIENT ROME.

By the Rev. R. Burgess, B.D.

(Read before the Royal Institute of Architects.)

In looking among my antiquarian and literary stores to prepare a subject for the Institute, I again found that it was not necessary for me to go out of old Rome, for although, in a series of papers spread over some twelve years, I have led you "o'er steps of broken thrones and temples," and placed you in forums, baths, or halls, I have never yet described to you the theatres and porticoes which formed so important a feature in the architectural beauties of Rome.

The amphitheatre was an edifice unknown to the Greeks, the theatre was hardly ever naturalized among the Romans, and with the exception of some tragedies, ascribed to Seneca, which are lost, it does not appear that a single Roman tragedy was ever composed upon a Roman subject. Porticoes, which were generally in the vicinity of theatres and circuses at Rome, are the natural growth of a climate subject to great heat and sudden rains: we lose in these northern regions that great ornament of a city, the portico. Our admiration is limited to arcades and covered markets, which it must be confessed are more for use than ornament. But I return to the theatre. The ancient and modern drama differ as widely as the buildings in which they were respectively acted, and I shall hardly succeed in making my Roman theatre intelligible, unless I first indicate a few of the leading features which run through the Greek drama and its Roman descendant. The subject is by far too vast and intricate for me to attempt anything like an essay upon the Greek stage, and therefore I must limit my observations to what is strictly necessary for explaining the internal arrangements of the edifice. The Greek drama dealt more in set speeches than in broken dialogues, and did not admit more than three interlocutors at once: the action or event represented was brought within the space of time, in which it might in reality have been accomplished. As a general rule, there was no change of scene during the piece. In every tragedy there was a body called a chorus, who took no part in the action of the piece, but reflected upon what was going on, and generally expressed what might be supposed to be the sense of the audience. The chorus did not come upon the stage, but occupied the orchestra, varying the dialogue which they sometimes held with the actors by choral songs and dances. These terms of *stage* and *orchestra* I shall have shortly to explain.

Dramatic entertainments, both in Greece and Rome, formed part of the public expenditure, or they were exhibited gratuitously by some wealthy or ambitious citizen. The theatres, therefore, were of immense size, for they were meant to contain (in Greece, at least) the whole male population of great cities. The performance usually took place also in an uncovered theatre in Greece, but Roman luxury, at a later period, invented the awning. I once described to you, when I read a paper on the Colosseum, how this awning was contrived to cover such an immense space; and I must be allowed to suppose that you have not entirely forgotten that description. If any of you are desirous of satisfying your curiosity upon the Greek stage, I must refer you to Butenger de Theatro, for I now hasten to the buildings themselves, which it is the principal object of this paper to describe. The origin of the theatre is rather ignoble;—it was originally a waggon, in which Thespis conveyed his actors about, with their faces besmeared with lees of wine, and from which they spoke their parts to the crowd assembled around them. To the ambulatory waggon of Thespis succeeded a moveable wooden structure, which was set up and taken down at pleasure; and it was in consequence of one of these structures having given way under an unusual crowd, that the first stone theatre was erected in Greece, by Themistocles, not long after the defeat of Xerxes. From this they began to increase in number, and we have the remains of several yet existing, both in Greece and that part of Italy which was Greek in language and customs long after it came under the Roman dominion. We have also those remains of Greek theatres in Rome, to which I shall shortly direct your attention. A theatre became so necessary an appendage to a town, that Vitruvius gives systematic direction concerning the selection of a site. In his fifth book, cap. 3, we have the following:—"When the forum is finished, a healthy situation must be sought for, wherein the theatre may be erected, to exhibit sports on the festival days of the immortal gods; for the spectators are detained in their seats by the entertainment of the games, and remaining quiet for a long time, their pores are opened and imbibe the draughts of air, which, if they come from marshy or otherwise unhealthy places, will pour injurious humour into the body. Neither must it front the south, for when the sun fills the concavity, the enclosed air, unable to escape or circulate, is heated, and then extracts and dries up the juice of the body. It is also to be carefully observed that the place be not dull, but one in which the voice may expand as clearly as possible." One cannot let pass this quotation from the great architect of the Augustan age, without remarking that the selection of a site for an important public building was considered by Vitruvius as falling within the province of the architect. A healthy place for the theatre selected, we come next to consider its shape and disposition.

The form of the Greek theatre originated, as is thought, in the natural recess of a hill-side, and most of the theatres whose vestiges I have visited in Greece occupy that position. Mantenela, built in a marshy place, offers an exception, and I believe there is another exception in Asia Minor; but it was evidently the practice to lighten the labour of erecting such buildings, by making use of a ravine, or locality adapted to the purpose. At Megalopolis I was able to trace the whole cavea or hollow of the theatre, partly cut out of a hill; but the seats are overgrown with thick brushwood. The same economy is observed in most of the Greek stadia also, and even the council of Areopagus sat on seats, cut out of, or inserted into Mars' hill. At Nicopolis, near Prevesa, the form of the theatre on the hill-side is preserved, and much of the proscenium. At Smyrna I was able to trace the cavea in a similar position, and also at Ephesus we get to the slope of Mount Prion, which overlooked the temple of Diana, in the plain of the Cayster, before we find the theatre. Whilst the Greeks, however, hewed seats out of the rock, or excavated to a depth suitable to their purpose, as the nature of the ground allowed, the Romans usually built their theatres upon arches, and massive walls rose (as we see the theatre of Marcellus still existing at Rome), with two or three orders, like the Colosseum. The hollow which perhaps originally was adjusted according to the nature of the ground, in no definite curve, ended in a perfect semicircle. This was called in Greek "κοιλον," and in Latin "cavea," and was the part for the audience. The other part was devoted to the business of the play, and thus we arrive at the two principal parts or divisions of the theatre. The κοιλον, or cavea, is easily described; it was bounded by the segments of two concentric circles, the inner arc separating it from the orchestra; in the Roman theatre it seldom exceeded a semicircle, but sometimes the extremities of the semicircular are were prolonged by straight lines; the Greeks took more of the circumference of the circle, and cut the κοιλον by lines drawn from its extremities converging towards the centre of the circle, by which arrangement more space was made in width for the scene or stage. The cavea was fitted up with rows of seats rising in succession, so as to afford each tier an uninterrupted view: the whole was divided, as in the amphitheatre, into flights by διαζωματα, or "præcinctiones," which is the Vitruvian term for our landing-place. The præcinctio ran round the whole, and afforded an access from one flight to another. The entire arc was again cut into subdivisions, called κεκιδες, in Latin, *cunei*, from being formed like wedges; the lines which effected those subdivisions were called κλιμακες, or *scalæ;* these (which in the Roman circus were called *vice*) led from the bottom to the top of the theatre; and they all converged to the centre of the orchestra. The lowest seats were considered the best, and were, in fact, the reserved seats for the magistrates and persons of office. As the audience rose in height, it descended in quality, until it reached the open portico at the very top, which has its counterpart in our shilling or sixpenny gallery. This portico, however, in an uncovered building, was of some use in confining the sound and giving shelter to the spectators from a passing storm. A κοιλον, or cavea, such as I have now described, would contain, in some of the largest theatres, as many as 30,000 or 40,000 spectators, which is about the capacity of those whose remains are yet to be seen in Rome. I now come to the other part of the theatre, which is more complicated and more difficult to describe. In Greek, we have to deal with the three terms of ορχηστρα, σκηνη, and παρασκηνια. In the Roman language, we have the three corresponding terms of orchestra, pulpitum, or scena, and postcenium, to which we are to add the porticus. I shall content myself with describing the Roman arrangements, and simply pointing out where the Greek theatre differed. Taking the cavea to be a semicircle, the concentric arc which separates the audience was also a semicircle, and this space, bounded by the diameter, was the orchestra,—not so called from anything relating to music, but because it was the place for the dancers. In the Greek theatre the segment was less than a semicircle; but if the circle be completed and a square inscribed in it, whose sides are parallel to the diameter, the side farthest from the cavea fixes the front of the stage; but in the Roman theatre the diameter itself determines the front of the stage, or pulpitum. The stage, therefore, in the Roman theatre, is brought nearer to the audience, and made deeper. The length of the stage was two diameters of the orchestra. The increased depth was rendered necessary on account of the greater number of persons assembled upon it; for the Romans put both the chorus and the musicians upon their stage. The points from whence the several staircases began to ascend the cavea were fixed by the vertexes of four

equilateral triangles, inscribed within the circle (when completed) of the orchestra. In the Roman theatre, as we have already observed, the front of the stage was called the pulpitum; and it was from that part that the interlocutors spoke. Some think the pulpitum was a little elevated above the level of the stage; but, at all events, the word has passed into use for designating a place to speak from in our sacred edifices. The lowest range of seats was raised above the area of the orchestra (one-sixth of its diameter), and the seats themselves did not exceed 1 foot 4 inches in height. The stage in the Roman theatre was only elevated 5 feet above the seats in the orchestra: in the Greek theatre it was double that height. I have only hinted at the geometrical precision with which all these things were defined, and I shall relieve you from such dry details by a reference to the drawings behind me. The postscenium speaks for itself: it was a long narrow gallery behind the scene, where the actors retired, and where apartments or compartments were provided for them. From the postscenium were passages into the porticoes and gardens, which generally surrounded the theatres; but to these I shall have occasion to refer when I have finished the history and description of the theatres at Rome, to which I now come.

I have already remarked, that the earliest theatres at Rome, as well as at Athens, were but temporary erections of wood. The Romans were satisfied with standing-room for 200 years, and no seats were allowed, "lest," as Tacitus says, "if the people sat, whole days might be spent in idleness." Notwithstanding this prohibition to build permanent theatres, the temporary edifices were constructed with a magnificence which surpasses all belief. The wealth which supplied those theatrical exhibitions was generally the plunder of rich provinces, easily earned, and as easily dissipated, merely to obtain favour with the people, and procure still more lucrative appointments. All the bribery and corruption that ever came before a committee of an English House of Commons sink into insignificance, compared with those times "when Rome was free." The treating of our "worthy and independent electors" at the open house of the candidate was economy and parsimony compared with the lavish expenditure of a candidate for the honours and emoluments of a Roman governorship; and we cannot doubt, that whilst those worthy citizens were feasting for whole days at the expense of a Scaurus or a Curio, they would be loud in the praises of liberty; and had they known how to put their exclamations into the polite language of modern Europe, the air would have resounded in the midst of those entertainments with "Vive la Republique." It was not until the year of the city 699 (that is, within 53 years of the Christian era), that a theatre of solid materials was built at Rome, and this was constructed by Pompey on his return from Asia, at the close of the Mithridatic war; but even Pompey found it expedient to pay a deference to the popular feeling. "Therefore," says Tertullian, "Pompey the Great, less great by his theatre only, when he erected that stronghold of wickedness, dreading lest the rebuke of the censor might injure his memory, he built a temple to Venus on the top of it; and when he invited the people to come to the dedication, he did not call it a theatre, but the Temple of Venus, to which," he said, "we have subjoined seats for seeing shows." The seats were therefore considered as the steps by which to ascend to the temple. We may call this either a pious fraud or a legal fiction. A piece of marble was found, in 1525, near the site of Pompey's Theatre, on which Marliano read the words, "Veneris Victricis." This building was erected in the third consulate of Pompey, and when the inscription came to be placed on the frieze, a dispute arose whether it should be *cos. tertio* or *tertium*. The matter was referred to Cicero, who advised the disputants to settle the controversy by writing *cos. tert.*

At the dedication of his famous theatre, Pompey produced twenty elephants; and when he was accused in the senate of introducing too much luxury into the city, he convinced the conscript fathers that it was an economy to build a solid theatre at once, instead of raising a temporary structure on every occasion of giving shows. The Temple of Venus served very well as a pretext for making seats "*gradus spectaculorum*;" but it could not equally be alleged for erecting a solid stage. It was not until the reign of Tiberius that this part of the theatre was added, and finally completed by Caligula. It was dedicated anew by the Emperor Claudius, who restored it after a fire, and it reached its greatest splendour in the time of Nero. Two vanquished chiefs, that came from the north of Germany to render submission to the emperor, were taken to Pompey's theatre, in order that they might see the greatness of the people. It contained, according to Pliny, 40,000 spectators; and when Tiridates, king of Armenia, came to Rome, Nero caused the whole to be gilded, to show off the magnificence of the Romans to the vanquished Asiatic. It passed through a succession of fires, until Theodoric commissioned Symmachus to rebuild it; but not long after, it shared the fate of the rest of the splendid edifices of Rome, and finally came into possession of the Ursini family, who occupied that quarter of the city in the wars of the middle ages. In the fifteenth century, an inscription, found with the name of Pompey, directed the antiquary to find out its site. Another indication of the place where this theatre stood was given in the finding of the famous statue which is now in the Palazzo Spada. That statue was found under the partition-wall of a house, and lying across in such a way as to give two proprietors of the house a claim to the treasure; not able to agree about dividing the spoil, they came to the resolution of cutting Pompey in two, and each man taking his own half. The matter having reached the ears of Cardinal Capodifezzo, he hastened to Pope Julius III. to inform him of the judgment that had been pronounced upon the statue. The astonished Pope despatched a messenger with all haste, and sent 500 scudi to be divided between the litigants, instead of Pompey. Flaminius Vacca, who relates this anecdote, says the statue was found near the Palazzo della Cancelleria, in the Vicolo dei Scutari. The statue did not stand in the theatre, but in the Curia which Pompey built as an appendage to it; and the belief still obtains that it is the statue at the feet of which Cæsar fell. Being thus directed to the site of this famous building, we find ourselves in the immediate neighbourhood of the Church of St. Andrea della Valle. From near that church to the Palazzo Pio, the site is marked by a gradual rising of the ground, but no vestiges meet the eye. In order to see the remains of Pompey's Theatre, we enter the court-yard of the Palazzo Pio, and, descending into the vaults upon which the Palazzo is built, we find ourselves, at the depth of forty Roman palms, among the foundation arches. These have been originally hollowed out of the natural rock, and they are pointed at the angles with large blocks of peperine stone. One of the "cunei," or sections of the cavea belonging to the lowest tier, may be perfectly traced; and, after ascending to the court-yard again, and entering the stables, we see a second story of arches for supporting the seats. The construction is remarkable for its solidity; and it would not be difficult to trace, among the modern buildings and in the cellars of the Palazzo, at least one-half, perhaps two-thirds, of the whole cavea. I will not stay to describe to you blocks of peperine and "opus reticulatum,"—for the great point gained by tracing the "cunei," is the fixing of the position of the scene or stage. This appears to have reached very near the present site of the Church of St. Andrea. But the most remarkable circumstance attending the investigation of the buildings erected by Pompey in this part of Rome, is the being able to present a ground-plan of them, although they have almost all vanished from off the face of the earth. In the sixteenth century, there was found behind the Church of SS. Cosma and Damiano a plan of ancient Rome, done in marble, and which had served to encrust the walls of the temple (it is supposed) of Romulus and Remus. This marble map, where the ground-plan of all the public buildings was laid down, was found broken into fragments; some of them irrecoverable; others, gathered up with care and put together, presented an idea of a building. They now encrust the walls of the staircase of the Capitoline Museum, and are known under the designation of the Pianta Capitoline.* The two fragments most perfect happen to represent the Theatre of Pompey and the Portico of Octavia. By a reference to that fragment of the Pianta, you will not only see the ground-plan of the theatre, but also of some other buildings, which were attached to it. Vitruvius cites the Porticus Pompeiana as an example of what a portico should be, when attached to a theatre for the convenience of the actors, or for the people to take shelter in in case of rain. We know, from Martial, that Pompey's Portico had a hundred columns. Eusebius calls it, in consequence, Hecatonstylon. The "Pianta Capitolina" exhibits some of those columns, but the fragment is imperfect. This celebrated portico was painted by artists of renown—Antiphilos, Pausias, and Niceas—the subjects being suited to the atmosphere which Ovid's lovers breathed. About the portico were rows of plane trees, interspersed with stone statues of beasts; and a fountain threw up, or poured out, its sparkling waters. The Pianta Capitolina exhibits two rows of columns, running in a direction towards the river, and not unlikely conducting to a grove along the banks of the Tiber. Besides these appendages to the theatre, there was the Curia, or Senate-house, which is, no doubt, identical with the "Regia Theatri" of Suetonius; but I must forbear to expatiate beyond the proper limits of my subject. A careful inspection of that part of Rome where all those buildings stood, with the aid of the Pianta Capitolina and the antiquarian notices which I have cited, might still furnish a fine subject for the genius of a restoring architect; and when we consider that those extensive and magnificent buildings (whose very remains at the end of nineteen centuries excite our wonder) were erected out of the private resources of a single individual, it will be long before we find in another republic a popular favourite, who may vie in wealth, taste, and splendour, with citizen Pompey.

* These fragments were first engraved and illustrated by Bellario, and are reproduced at the end of tom. iv. of the Grævius' Roman Antiquities.

I shall pass quickly over the next theatre, which time and floods have not spared. It was erected in the twelfth year of the Christian era, by Cornelius Balbus, in compliment to Augustus, and was capable of containing 33,000 spectators. I am not aware that a vestige of this theatre remains, but Piranesi took considerable pains to ascertain the site, and found some remains of one of the "cunei." The Palazzo, and Monte Cenci, now point to where it stood; and Camucci, one of the oldest of Roman antiquaries, who probably saw some remains of it in his time, states that, from its vicinity to the Tiber, it frequently suffered from inundations. We are not aware of any portico attached to this theatre, but there was a crypta Balbi, which stood near it, and of this there are some remains.

REPORT OF EXPERIMENTAL INVESTIGATIONS ON COALS FOR THE STEAM NAVY.

By Sir H. De La Beche, and Dr. Lyon Playfair.

(Abstract of Appendix concluded.)

If we compare the following analyses, it will be found that the Mynydd Newydd coals are so similar in their composition to those used in the Cornish experiment, as to be considered practically identical:—

Analyses.

	Mynydd Newydd.	Cornish.
Carbon	84·26	84·19
Hydrogen	5·61	4·19
Ash	3·26	8·06
Sulphur	1·21	1·90
Nitrogen	1·56	0·80
Oxygen	3·52	0·86
Total	100·00	100·00

The practical trial made on the Mynydd Newydd coal in the experimental boiler, gave 9·52 as its evaporative value; if, then, we assume that the two coals possess equal calorific powers, the evaporative values of the two boilers will evidently be as 9·52 is to 11·42; or, in other words, the Cornish boilers will be found to possess a superiority of nearly 20 per cent. over that used for the purposes of the investigation.

Assuming, then, the economic equality of these two coals, we have only to multiply the results obtained by the various coals during our own experiments by 1·1995, in order to ascertain their several evaporative values if consumed under the Cornish boilers.

The following Table has been calculated upon this assumption,* and should therefore be considered only as an approximation:—

Names of Coals.	Evaporative Power. Commissioners' Boiler—Actual.	Evaporative Power, Cornish Boiler—Theoretical.	Names of Coals.	Evaporative Power. Commissioners' Boiler—Actual.	Evaporative Power. Cornish Boiler—Theoretical.
Mynydd Newydd	9·52	11·42	Bedwas	9·79	11·74
Graigola	9·35	11·21	Ebbw Vale	10·21	12·24
Anthracite (Jones & Co.)	9·46	11·34	Porthmawr	7·53	9·03
Old Castle Fiery Vein	8·94	10·92	Dalkeith Jewel Seam	7·08	8·49
Ward's Fiery Vein	9·40	11·27	" Coronation Seam	7·71	9·24
Binea	9·94	11·92	Wallsend Elgin	8·46	10·14
Llangennech	8·86	10·62	Fordel Splint	7·56	9·06
Pentrepoth	8·72	10·46	Grangemouth	7·40	8·87
Pentrefelin	6·36	7·62	Coleshill	8·00	9·59
Powell's Duffryn	10·149	12·17	Broomhill	7·30	8·75
Three-quarter Rock Vein	8·84	19·60	Lydney	8·52	10·22
Cwm Frood Rock Vein	8·70	10·43	Slievardagh (Irish)	9·85	11·81
Cwm Nanty-gros	8·42	10·10	Wylam's Patent Fuel	8·92	11·70
Resolven	9·53	11·43	Warlich's "	10·36	12·42
Pontypool	7·47	8·96	Bell's "	8·53	10·23

Another Report on the evaporative power of different sorts of coal (chiefly Welsh), is given by Professor Wilson and Mr. W. J. Kingsbury. Mr. Wilson visited all the shipping ports of South Wales for the purpose of making himself acquainted with and obtaining samples of those coals most approved of, and best adapted for steam purposes. The following Table gives the general results:—

* The Mynydd Newydd coal, supposing there was no loss of heat, is capable of evaporating 14·90 lbs. of water, and the Welsh coal (used in Cornwall) 14·28 lbs.; but considering that this heat cannot all be obtained in practice, these economic values for calculation might be taken as equal without introducing any serious error.

Table of the Results of Experiments made by Professor Wilson and Mr. W. J. Kingsbury.

Names of Coals employed in the Experiments.	Evaporating power, or number of pounds of Water evaporated from 212° by 1 lb. of Coal—Economic.	Weight of 1 cubic foot of the Coal as used for fuel—Lbs.	Weight of 1 cubic foot of the Coal as calculated from the density—Lbs.	Ratio of B to C, or the economical to the theoretical weight.	Difference per cent. between theoretical and economical weights.	Space occupied by 1 ton in cubic feet—Economic weight.	Results of experiments on cohesive power of Coals, per centage of large Coals.	Evaporating power of the Coal, after deducting for the combustible matter in the residue.	Per centage of residue in the Coals.—Mean.
	A.	B.	C.	D.	E.	F.	G.	H.	I.
Pentefrelin	6·36	66·166	87·726	·781	28·051	33·85	52·7	7·4	27·7
Duffryn	10·149	53·22	82·72	·643	55·43	42·09	56·2	11·80	7·81
Old Castle Fiery Vein	8·94	50·916	80·42	·633	57·946	43·99	57·7	...	6·57
Binea	9·446	57·08	81·357	·702	42·53	39·24	51·2	10·3	8·22
Mynydd Newydd	9·52	56·33	81·73	·689	45·09	39·76	53·7	10·59	8·28
Resolven	9·53	58·66	82·354	·712	40·39	38·19	35·0	10·44	4·71
Anthracite (Jones & Co.)	9·46	58·25	85·786	·679	47·26	38·45	68·5	9·7	9·58
Ward's Fiery Vein	9·4	57·433	83·85	·685	46·	39·	46·5	10·6	7·44
Llangennech	8·86	56·93	81·85	·695	43·76	39·34	53·5	9·2	11·04
Three-quarter Rock Vein	8·84	56·388	83·60	·674	48·26	39·72	52·7	...	7·36
Graigola	9·35	60·166	81·107	·742	34·8	37·23	49·3	9·66	9·27
Lydney (Forest of Dean)	8·52	54·444	80·046	·68	47·02	41·24	55·0	8·98	4·06
Pentrepoth	8·72	57·72	81·73	·705	40·17	38·80	46·5	8·98	10·47
Cwm Frood Rock Vein	8·70	55·277	78·299	·706	41·648	40·52	72·5	9·35	7·8
Cwm Nanty-gros	8·42	56·0	79·859	·701	42·60	40·00	55·7	8·82	5·44
Wylam's Patent Fuel	8·92	65·08	68·629	·948	5·45	34·41	70·0	9·74	7·27
Grangemouth	7·4	54·25	80·48	·674	48·35	40·13	69·7	7·91	5·26
Broomhill	7·3	52·5	77·988	·673	48·55	42·67	65·7	7·66	3·23

Section III.—Formulæ for estimating the evaporative value of fuel. By Messrs. Wilson and Kingsbury.

Section IV.—Chemical analyses of coals. By Mr. F. C. Wrightson.
Ditto, by Mr. H. How.
Calorific values of coals. By Mr. J. A. Phillips.

The method adopted by Mr. Phillips was to ascertain the quantity of litharge reduced by a given weight of each sort of coal. The coal was first reduced to a fine powder and mixed with the litharge; the mixture was then ignited, and the button of lead resulting from the fusion, weighed. The value of a combustible, being in a direct ratio with the quantity of oxygen necessary to consume it, and the weight of the button being also in proportion to the amount of oxygen abstracted from the oxide, it follows that the latter must be an exact measure of the former. The coal which gave the heaviest button was Jones and Anbrey's anthracite (167·4); the least, the Dalkeith Coronation Seam (122·8).

PORTABLE COFFERDAM FOR HARBOUR AND MARINE WORKS IN EXPOSED SITUATIONS.

By Thomas Stevenson, Esq. C.E., Edinburgh.

(Read before the Royal Scottish Society of Arts.)

When it is necessary, in the execution of marine works, to carry on founding or excavation in exposed situations within the high water-mark, cofferdams of the common description are not found to be answerable. Many circumstances conspire in rendering such erections inapplicable in situations where they are required to stand for several tides. The waves occasioned by a very moderate breeze of wind will, in many cases, even in the course of a few hours, either entirely break up a well-constructed cofferdam, or render it leaky and unserviceable. Again, where there happens to be a covering of a few feet of sand above a rocky bottom, the piles will be found, even where there is shelter from the waves, to have no stability, and to fall inwards as the sand is removed from the interior, although every care be taken to support them with *shores* or struts.

The temporary dams which are generally employed in the execution of tide-works are of a very simple construction, and are intended to be serviceable during only one or two tides. They consist of a row of short piles, which are driven in the line of a runner or waling-piece; and as the excavation proceeds, the piles are from time to time driven farther down. But this kind of erection is very unsatisfactory, and in many situations, and for a variety of purposes, it is in fact quite useless; for I have always found that it was impossible with this dam to drive the piles straight, from there being only one waling-piece to direct them. But even although they could be driven, a farther source of inconvenience still remains; for, as the stuff is removed from the interior, there is nothing left but the single waling to resist the pressure from the outside, and the bottoms of the piles being speedily forced inwards, all attempts to carry the excavation farther must necessarily be abandoned.

At Hynish harbour, Argyllshire, in 1843, I had a talus-wall to found on sand, which covered a rocky beach to the depth of from two to three feet. At another place, the rock was not only to be hared, but a navigable channel, twenty feet wide, and in some places as deep as eight feet in the rock, together with a small tide-basin, were to be excavated to the level of the low-water springs. The shores also were frequently subject, even during the summer months, to a very heavy surf.

The excavation of the tide-basin, which formed the landward part of the work, was effected by means of a series of dams, consisting of walls, built of Pozzolano rubble. These were found to be quite water-tight, and to answer remarkably well in every respect; but they required, for their protection against the waves, a considerable bulwark or breakwater of *Pierres perdues* to shelter them from the waves.

In the excavation, however, which had to be undertaken seaward of the breakwater of *Pierres perdues*, any attempt to exclude the water during the whole of the tide was what I never considered practicable. A trial was accordingly made to effect the excavation by means of a low wall, composed of clay-rubble, resembling in its object those low dams consisting of logs of wood bedded in clay, which are often adopted in harbour-works, and which are only intended to keep out the tide during the first part of the flood, and to be pumped dry before the operations of the next tide are begun. But after many attempts with this clay-wall, it became quite evident that it would not be possible, with its assistance, to carry the excavations to near the level of low-water springs, which was due principally to two causes. *First*, because sand and shingle were, during almost every tide, washed in large quantities over the top of the wall into our excavation pit; and, *secondly*, because the waves washed out the clay from among the stones, so as to render the barrier no longer water-tight.

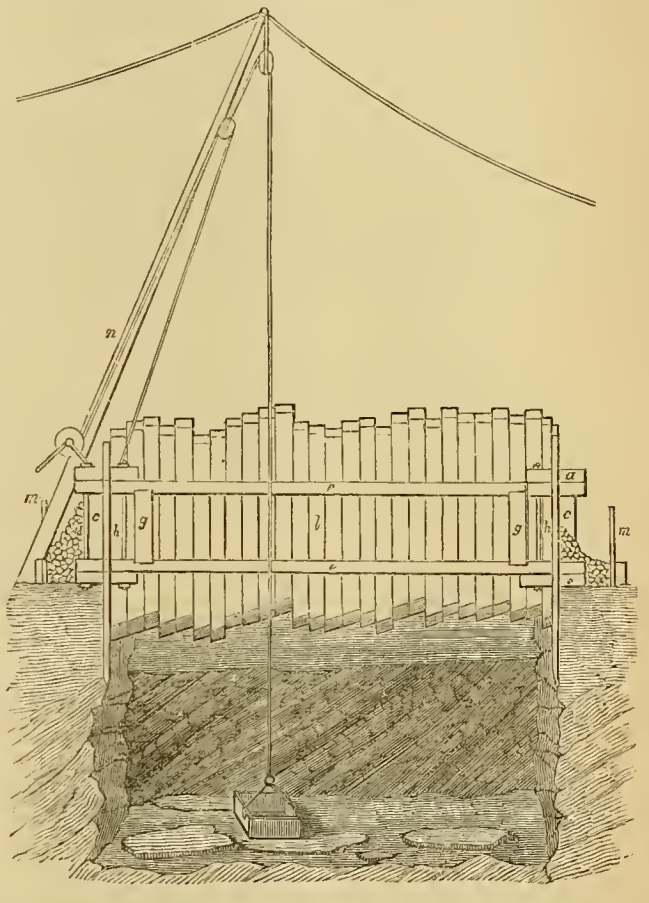
Being now compelled to set about some other way of carrying on the work, I had recourse to the simple method shortly to be explained, and which more than realized my expectations. Before giving a description of this method, however, it will be interesting, as well as still farther explanatory of the required objects, to quote a few lines relating to somewhat similar difficulties, from a Report upon the Harbour of Peterhead, which was drawn up in the year 1806 by the late Mr. John Rennie:—"The next material object of consideration," says the Report, "is that of deepening the harbour, which at present cannot well accommodate vessels drawing more than 12 feet of water in the spring-tides, but in neaps is not sufficient. To render this harbour more extensively useful, it would be advisable to have 17 or 18 feet of water over the greatest part of its bottom, and particularly along the west quay. The mode of performing this kind of work will be different, according to the difference of situation. Those places where the tide ebbs from the surface, and continues so for some time, may be done by blasting, or by loosening the stones with quarrying tools in the usual manner; but in those parts where the tide seldom leaves the bottom, and in others but for a short time, different methods must be resorted to. The best of all would be enclosing large spaces by cofferdams, and working at all times of tide by quarrying tools or blasting, as might best suit; but in some situations this would be inconvenient, as the dams would be in the way of vessels going into and coming out of the harbour. In such situations, perhaps the simplest and most expeditious mode would be to use cast-iron cylinders of 7 or 8 feet diameter, having strong canvas fixed to the lower flanch, which might be kept to the bottom by bags of sand in places where there was but little agitation; but where there is much, an outer cylinder might be sunk thereon, to keep them in their situations."

The cylinders proposed by Mr. Rennie were, no doubt, quite adequate to the special purpose and locality for which they were designed, and they unquestionably possess some advantages not to be gained by other means; but, on the other hand, they are attended with difficulties and disadvantages which precluded their adoption in the present case. Those objections were the limited area, the weight and unwieldiness of such cylinders, their inflexible nature and unalterable form, as affording no means in themselves of adaptation to the very irregular rocky bottom which was to be excavated, and, what was of as much consequence, the difficulty which must have attended the removal of the partitions of rock, or those parts which would necessarily be left between the different compartments of the cutting. The last two objections, it may be remarked, refer equally to wooden caissons, or other contrivances on the same principle.

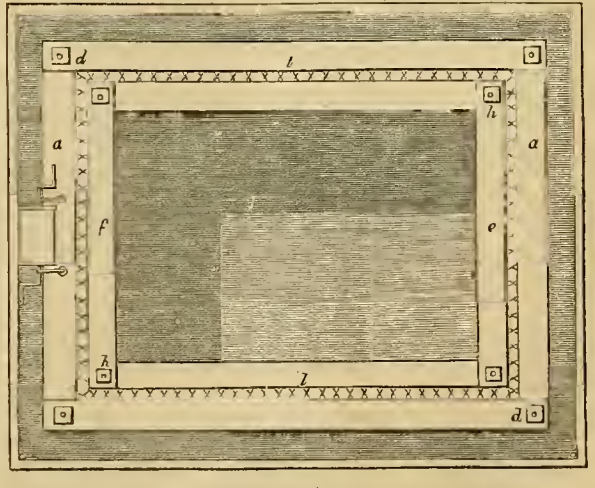
In the present case, then, the following requisites were to be provided for. In the founding of the talus-wall, all that was required was some method which would enable the found-stones to be laid as deep in the sand as possible, for which purpose the dam did not require to be absolutely water-tight, provided it were capable of excluding from the inside the sand which was so liable to replace what was removed from the interior. For the excavation of the rock, on the other hand, it was necessary that the dam should be water-tight, and suitable for taking out all the partitions; and both situations required piles for fitting close to the irregular bottom, and those piles needed some support other than the soil into which they were to be driven.

To effect such objects, it was clear that the means to be adopted must be at once easily managed and efficient. For although, where there is time for their employment, many complicated and troublesome refinements of construction are forced to answer purposes which might have been attained by simpler means, or by less cumbrous arrangements, yet I was well aware that in the hurry and bustle attending tidal operations and night work, nothing can be tolerated but what is in every respect easily managed and truly efficient.

Sectional Elevation.



Plan.



1 inch = 6 feet.

In the preceding woodcuts, *a b* represents a frame of double waling-pieces, connected at the angles by the uprights, *c*, and bound together by the long bolts, *d*, with forelocks and washers; while *e f* shows similar double-framed walings for the inside of the dam, and of smaller dimensions, with their uprights, *g*, and connecting bolts, *h*. These frames being placed in the required position, the one frame inside of the other, the piles, *l*, are driven down between them with heavy malls.

The dam was 12 feet long by 10 feet broad inside, so that five men were able to work in the interior.* If it was to be fixed within low water-mark, the two frames being placed in the water, were guided to the spot by the men in charge, and whenever they were in the desired position, the men at once moored or fixed the frames to the bottom, by driving down a pile at each corner. After this was done, all the piles were placed between the frames and driven down, and keyed up by the small piles called "closers." Four iron jumpers, *m*, were then driven down to their proper places outside of the frames, and edge planks for retaining the clay were slipped down upon the jumpers through iron staples which were fixed to the planks. After this, good clay (which should have some gravel mixed with it, to protect it from the wash of the sea) was *punned* hard between the planks and the cofferdam; after which the mast, *n*, was erected, and the water taken out by means of the iron scoop shown in the woodcut, which not only was used in taking out stuff, but proved far more efficacious than any pump we ever had. Indeed, to get the dam pumped dry was for long the greatest difficulty we had to contend with. But Mr. William Downie, to whom I gave the charge, soon removed this difficulty, by using the scoop instead of a pump. The capacity of the scoop was about 37 gallons, and they generally made nine deliveries a-minute, so that we found this method greatly more expeditious than any other.

As the excavation proceeded, the piles were from time to time driven down; and when the rising tide began to come over the pile heads, or to rise above the clay, the men, before leaving their work, placed the flooring or "deck," as it was called, within the piling, with the ends of the planks resting upon the top of the inner frame. On this deck, ballast (consisting of stones of a convenient size) was deposited to prevent the whole frame from being floated up—the quantity so deposited varying with the height of the tide, or appearance of the weather. As each compartment of the excavation was completed, and before the dam was removed, the rock below the two rows of piles which adjoined the next cuttings was completely taken out, and the piles driven down to the bottom of the excavated pit, and left standing.† When the dam was taken up, the frames were, for the next compartment of cutting, again superimposed upon one of the rows which had been left standing in the last pit. In this way no rock could possibly escape being removed; and when the frames were to be put down anew, there was no difficulty (although the pit was entirely covered with sand) in knowing exactly the position which they were to occupy, as the piles which had been left standing were an infallible guide.

The advantages peculiar to this description of dam are its cheapness—its portability—its ready adaptation to a sloping, or even to a very irregular bottom—the ease and certainty with which the partitions between the different pits are removed, and the double-framed walings that support and direct the driving of the piles. Wherever excavations require to be made in a rocky beach, covered by a stratum of sand, however thin, there need not be any hesitation in adopting this form of dam, as there is no kind of lateral support, such as stays or shores wanted, the structure containing within itself the elements necessary for its stability. It possesses, indeed, all the properties of a caisson, and has the farther advantage of accommodating itself to an irregular bottom.‡

I may observe, in conclusion, that although this form of construction is specially adapted to marine works, in the execution of which it has proved a most valuable auxiliary, the same principle might also be carried to a greater extent, and be rendered fit, with little trouble, to answer for a variety of works—such as underfooting quay walls, founding bridges, and in removing fords or other obstructions from the beds of rivers. The application of a double-framed waling, I have also found in itself a very useful application in several situations, and for a variety of purposes.—*Edin. Phil. Journal.*

* Since this paper was printed, a cofferdam on the same principle, and 30 *feet square*, has been made for the Forth Navigation works, Stirling, where, in the removal of the "fords," under my direction, much difficulty has hitherto been experienced from the constant flow of the river.

† Before lifting the cofferdam, the pit was filled with sand, to support the piles that were to remain, which, when the works were done, was cleared out by means of a water-scour, provided for the purpose of keeping permanently open the navigable tract.

‡ In situations also, where there is a considerable depth of water, and where, consequently, the frames must be made so as to stand high above the ground, it will be found of great advantage to plank the outside of the frames between *a* and *b*. This will not only make the dam more water-tight, but have the effect of binding and strengthening the framework.

WORKSHOP ECONOMICS—CONSTRUCTIVE MACHINERY—CRANK-CUTTING MACHINE.

By Messrs. E. B. Wilson & Co., Railway Foundry, Leeds.

Illustrated by Plate 11.

Our present illustrative example of the economics of the workshop may be described as a triplicate machine, or combination of three separate and distinct tools—the lathe, the planing machine, and the cutting or boring machine. Its inventor, Mr. Robert Willis, the foreman of Messrs. Wilson's works, has ingeniously embodied in it the different movements and actions of these several tools, so as to perform operations totally unattainable by any of them alone. The specific employment of this tool is the cutting-out and finishing of the crank arms of locomotive engine axles; but it is obvious that it may be adapted to several varieties of work, where differential movements are necessary.

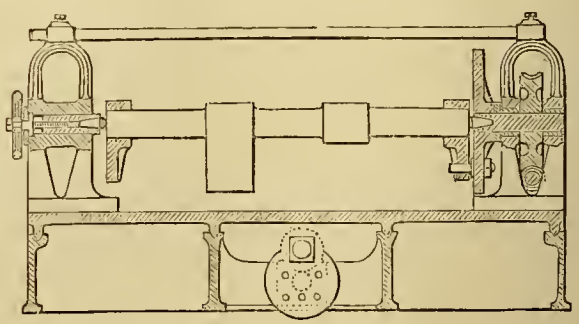
Fig. 1 of Plate 11 is an end elevation of the machine in the act of cutting out a crank axle. Fig. 2 is a complete plan corresponding.

The form in which the crank axle is received from the forge is that of a straight shaft, with two solid blocks projecting from its axis at right angles to each other, which blocks are to be converted into cranks. This conversion has hitherto been entirely accomplished by the distinct operations of the drilling and slotting machines and the lathe, a system at once expensive and ineffective. The drill is merely employed to make way for the more complete action of the slotting tool, the solid metal between the two arms of the crank being cut out piecemeal, as in a carpenter's mortice, and the crank pin is left square, requiring the subsequent assistance of the lathe to render it cylindrical. The crank-cutting machine performs the whole of these operations at once *per se*. The main ground plate of the machine consists of a single rectangular casting, A, being a deep frame without a bottom; and having two standards, B B, with pedestals on their tops, bolted to its sides for carrying the hollow cast-iron cutter bar or shaft, C. Upon this shaft is fitted a cast-iron disc, D, like the boring block of an ordinary boring machine, and fitted with a series of cast steel cutters, E, the cutting edges of which are accurately formed to the intended finished curvature of the crank neck or pin, as shown in dotted lines at F.

The machine is driven by the pulley, G, running loose on the shaft, H, its boss being connected with a small pinion, I, gearing with a large spur wheel, K, working loose on an intermediate shaft, L, and connected by a long boss with the pinion, M, so that the two move together. The latter pinion gears with the spur wheel, N, fast on the shaft, H, carrying the second pinion, O, gearing with the spur wheel, P, keyed on the second shaft, L, which passes through the side of the frame, and carries a pinion, Q, on its extremity, in gear with the interior toothed wheel, R, fast on the boring bar. (See the section, fig. 1.) By this arrangement of gearing, the cutters on the boring block are caused to move at the rate of 28 feet per minute.

Fig. 1.

Section through headstocks.



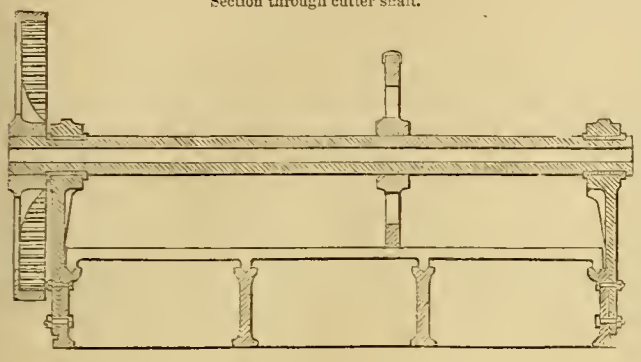
$\frac{1}{4}$ inch = 1 foot.

The axle, S, is fitted at each end with the cast-iron crank pieces, T T, and is adjusted upon its true centres on the headstocks, U U, bolted to the moveable table, V, sliding on V's on the bottom frame. The woodcut, fig. 2, represents the axle so arranged for turning its straight portion, after which its centres are changed, by setting centre holes in the extremities of the crank pieces, T T, to the centres of the headstocks, as represented in the Plate. In this way a false centre is given to the axle, so as to throw the centre of the crank necks in a line with the centres of

the headstocks, the length of the crank pieces, U U, being accurately set to suit the length of the axle cranks. Our engravings represent the machine just commencing to cut one of the cranks, the finished shape of

Fig. 2.

Section through cutter shaft.



½ inch = 1 foot.

which is shown by the dotted lines. The whole of the cut, from the commencement to the edge of the crank neck at E, is performed by the joint movement of the cutter disc and the horizontal traverse motion of the table, V. This traverse is effected by a worm, W, on the shaft, N, gearing with a worm wheel, X, on the shaft, Y, which carries at one end a pinion, Z, driving a wheel, *a*, on the traverse screw, *b*, working in a nut fast on the table. The table, with the crank, is thus carried forward towards the cutting disc, at the rate of 3½ inches per hour, until the cutters have advanced up to the line, E, when the traverse motion is thrown out of gear by a clutch on the shaft, Y, worked by the lever, *c*, a rod from which passes beneath the table to the front of the machine.

The neck of the crank is then completed by the circular traverse motion of the axle, which is obtained from the shaft, L. This shaft is fitted with a worm on its extremity, gearing with a worm wheel, *d*, the boss of which is fitted upon a feather on the end of the shaft, *e*, so as to allow of the traverse of the latter, along with the table, V, without interfering with its action. The shaft, *e*, communicates motion by a worm at *f*, to the worm wheel, *g*, fast on the revolving centre of one of the headstocks, U U. When the straight cut is completed, the clutch on the shaft, *e*, is put in gear with the boss of the worm wheel, *d*, and the axle makes one complete revolution on its false centres against the cutters, E, which thus complete the neck. The first block being completed in this manner, the other is cut out, simply by reversing the axle on its centre. The weight of the complete machine is 7 tons, and it completes one crank block of 12 inches radius in 9½ hours.

PRODUCTION OF SILVER IN SPAIN.

On the old continent, Russia is not the only state which has increased its production of precious metals. The progress has been almost general among such of the European states as possess them. The success which Russia has obtained, has been striking—incomparable. Nevertheless, it will be seen that some other nations have also made progress worthy of being cited. At the commencement of the century, Europe, without counting Russia, (which we here take in its whole extent, both to the east and west of the Oural Mountains), yielded, in pure metal, 1300 kilogrammes of gold, and 52,670 kilogrammes of silver. In 1835, the quantity of gold was about the same, but the production of silver was increased by about 15,000 kilogrammes. The production of gold and silver in Europe was, in 1835, as at the commencement of the century, concentrated in Germany, and in the lower part of the valley of the Danube—that is, to speak more precisely, in the Hartz Mountains, in Hanover; in those of Erzgebirge, which are divided among Saxony, Bohemia, and Prussia, in Hungary and Transylvania—the last two countries, let us repeat, having pretty nearly the monopoly of gold. Out of Germany, and the valley of the Danube, there was not produced in 1835 more than 10,000 kilogrammes of silver, of a value of about 2,000,000f., and from 20,000 to 25,000 kilogrammes of gold. Industry, which, since 1835, has taken a great extension in Europe, has paid more attention to the precious metals than it had previously done. At present, only little is wanting to make the production of silver double what it was in 1835. The principal cause of this development is, that Spain, which possesses important silver mines, formerly very celebrated, has again begun to work them.

The mines of gold, and particularly of silver, in Spain, have enjoyed great celebrity. Strabo, whose exactitude is better appreciated every day, states the fecundity of them. Long before him, the prophet Ezekiel had signalized it in his threatening prophecies against Tyre. The deposits of silver in the peninsula were worked with success under the Moors, as under the Romans. Since the country has had more liberty, the working has been resumed; and, at the same time, the numerous beds of coal, with inexhaustible mines of iron, which nature has placed in the Asturias, close to the sea, have begun to be worked with vigour.

The mines of lead, containing silver, situated in the kingdoms of Murcia and Granada, at a short distance from the Mediterranean, are those which formerly yielded, and still yield, a great quantity of silver. The lead, however, is not always associated with silver. The mines of Sierra de Gador, situated behind Almeria, which have yielded as much as 39,000,000 kilogrammes of lead, and still yield from 13,000,000 to 14,000,000 kilogrammes, do not contain silver; but the mines which are behind Carthagena, particularly at Almazarron, and still more particularly those that are worked in a little vale, called the Baranco Jaroso, in the Sierra Almagrera, in the kingdom of Granada, have a yield of silver very remarkable, being 1 per 100 with respect to the lead. Having been successively visited by several very intelligent French engineers, the mines of the south of Spain were, in 1845, worked anew by Mr. Pernolet, director of the mines of Pouliaouen, in Brittany. According to this gentleman, the single mines of the Sierra Almagrera yield, at present, at least 40,000 kilogrammes of silver; and consequently, the total extraction of the whole peninsula cannot be estimated at fewer than 50,000 kilogrammes.—*Hunt's Merch. Mag.*

THE CAMBRIAN STEAM-ENGINE.

In our mention of Messrs. Thwaites' Cambrian locomotive last month, we stated that this firm had improved upon the old construction, as introduced by Mr. Jones, by adopting a double-ended lever, working two separate cranks, in place of the single arrangement. We have since been favoured by E. H. Crosley, Esq., of the firm of Crosley, Son, and Galsworthy, with the accompanying sketches of a similar arrangement, proposed by the patentees some years back, for driving grinding machinery. The system of arrangement is identical with that of Mr. Hastie,* in as far as it embraces the employment of the crank shaft as the driving spindle of the upper stone. Fig. 1 is a front elevation of the engine as driving two

Fig. 1.

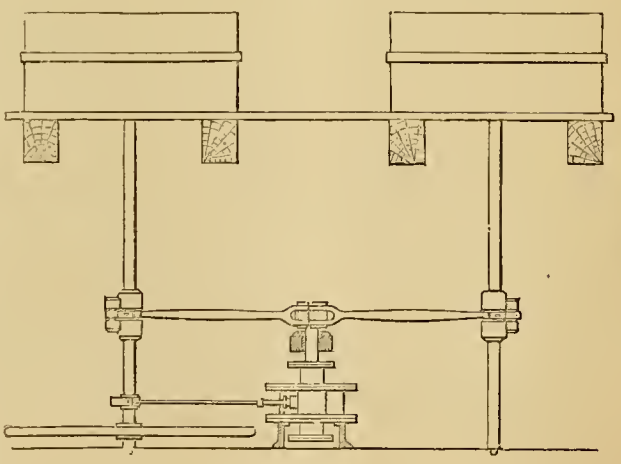
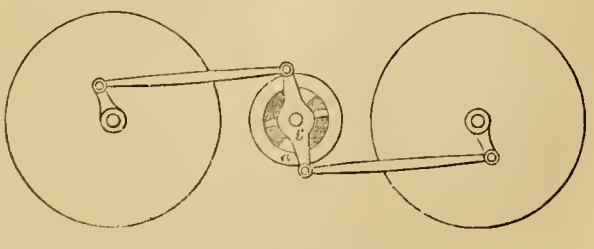


Fig. 2.



* See P. M. Journal, July, page 84.

pairs of stones; Fig. 2 is a ground plan. The latter figure will explain the construction of the steam cylinder, *a*; the dark sections of the cylinder represent the two steam chambers, in which the disc pistons oscillate upon the central shaft or piston-rod, *b*, steam being supplied alternately to opposite sides of these pistons. As represented, the engine is driving two pairs of stones only; but it is evident that four, six, or more pairs might be driven by one central engine, if the piston shaft was fitted with propelling levers to correspond.

We do not find that this plan has, so far, been put in practical operation, and to this end Messrs. Thwaites may still be considered as having been the first to adopt it, whatever the merits of the original design may be. According to the accounts given by different proprietors of these engines, the end wear upon the cylinder and piston is inappreciable; in fact, cases have been brought before us where no repair or adjustment has been required after two years' working. The advantages of the arrangement for marine and locomotive purposes, in point of compactness and direct action of the steam pressure, need no detail.

EXPERIMENTAL TEST OF CEMENTS.

A series of experimental trials was recently made at the Regent's Canal Iron-works of Messrs. Grissell, London, upon blocks of Portland and Roman cement and bricks, manufactured in the celebrated works of Messrs. J. B. White and Son, in order to procure data by which to calculate the actual strength of works composed of these materials. Each specimen of cement, as well as of the trial bricks, was formed into blocks 18 inches long, 9 inches thick, and the same width, and pressure was exerted on their ends by a hydrostatic press, the power of which was equal to 75 tons.

1. In the first experiment, a block of neat or pure Portland cement. of 30 days old, was subjected to a pressure of 22½ tons, at which pressure it scaled at one corner; with 37½ tons, the contrary corner scaled; at 52½, a slight split occurred; and at 56¼ tons, the block was spoiled for practical purposes, showing that its failing point was 70·3125 tons per square foot.

2. A block of neat Roman cement, 30 days old, stood a pressure of 26¼ tons without injury, but broke up suddenly at 27, being 33·75 tons per square foot.

3. A block of Messrs. White and Son's stock bricks, set as a 9-inch pier, of the same age as the preceding blocks, stood up to 15 tons, when the bricks began to crush, and the mass finally gave way at 16 tons, the initial crushing strength being 18·75 tons per square foot.

4. A block of stock bricks, set as a 9-inch pier, with Portland cement one part, sand three parts, same age as before. No effect was perceived until 26½ tons had been applied, when the mass gave way suddenly, the bricks cracking in the direction of their length, the strain being 33·125 tons per square foot.

5. A brick pier of the same construction, set with neat Roman cement, same age, broke up suddenly at 30 tons, without any previous crushing, the strain being 37·50 tons per square foot.

6. A block of Whitby stone from Cragwell quarry, vertical bed. This block began to scale at one corner at 45 tons, but required 71¼ tons to produce any perceptible effect upon the other, after which no further change took place up to the whole pressure of 75 tons, which gives 133·3 tons per square foot.

7. A block of Bramley Fall stone stood the same test without effect.

8. A block of concrete stone, 48 days old, composed of pieces of Portland rubble stone, cemented by a composition of Portland cement, and sand in the proportion of one to two, stood up to 22·5, tons, when it began to crack; at 24 tons, it was spoiled for use; and at 30, it broke up, being equal to 42·6 tons per square foot.

9. A similar block of concrete, cemented with one of cement, and three of sand, scaled at one corner at 15 tons, and crushed at 16·8 tons: strain about 28 tons.

10. A block of concrete, 270 days old, weighing 135 lbs. per cubic foot, was subjected to an initial pressure of 11 tons, gradually increasing, without any effect, up to 63·75 tons, when it fell to pieces with a loud report, showing equal fractures through the cement and stone: strain at 60 tons, 106·6 tons per square foot.

11. A block of one part Portland cement, two parts sand, 52 days old, weighing 127 lbs. per cubic foot, cracked slightly at one corner at 30·3 tons, but sustained no practical injury up to 45 tons, when it cracked throughout: strain, 80 tons per square foot. This block was steeped in water for a week soon after it was made, gaining in that time about 1 per cent. in weight.

12. Block of Portland cement one part, sand three parts, same age and weight, slightly cracked at 15 tons; broke up at 25 tons: strain, 44·4 tons. This was steeped in water as before.

13. Block of Roman cement one part, sand two parts, same age, and weighing 120 lbs. per cubic foot, gave way with something less than 3 tons: strain, 5·4 tons. Steeped as in the two last examples, and gaining 5 per cent. in weight.

14. Portland cement one part, shingle ten parts, 139 lbs. per cubic foot, cracked at one corner with 7·5 tons, and gave way at 10 tons: strain, 17·7 tons.

15. Messrs. White and Son's stock bricks, set as a 9-inch pier, with Portland cement one part, sand two parts, 52 days old, gave way slightly at 16·87 tons, and was crushed at 22·5 tons: strain 39·5 tons.

16. Same bricks set with Roman cement one part, sand two parts, same age, weighing 104 lbs. to the cubic foot, cracked at 5·62 tons, and was crushed at 14 tons; strain about 25 tons.

These results prove the superiority of neat Portland cement over neat Roman cement to be as 3 to 1; and of Portland cement, with two parts sand, over a similar mixture of Roman, of 15 to 1; and of Portland cement and three sands, over a like compound of Roman, of 8 to 1. If a composition of one cement and three sands is taken as an average for building purposes, it is here shown to possess a strength three times as great, and at no greater cost, than the ordinary compound of one Roman cement and one sand.

STEAM PREPARATION OF WOOD.

Some curious and valuable experiments have been lately made by a French philosopher, M. Violette, upon the steam preparation of various kinds of timber. The woods treated were oak, asb, elm, walnut, and fir, specimens of which he submitted to the action of a current of steam at a temperature of 100° centigrade, gradually raising it to the different points of 125°, 150°, 175°, 200°, 225°, and 250°, without the addition of any water, so that the vapour was no longer saturated, but was rendered capable of extracting the moisture contained in the wood. Portions of the various woods were weighed and exposed to these temperatures for two hours, in close vessels, and again weighed when cool, in order to find the amount of loss of weight by desiccation.

This loss was found to increase in a constant ratio, according to the temperature; but great variations were experienced with different woods. At the temperature of 175°, elm and oak lost one-third of their weight, and at 250° one-half; ash and walnut lost one-fifth at 175°, and two-fifths at 250°; and fir, one-sixth and one-third at the same temperatures. Until the heat reached 175°, they each preserved their primitive colours, but from that point to 200° a slight change took place. Above 200° the colour gradually deepened, and at 250°, oak became black. This change of tint indicates the formation of tar in the wood, which seems to be necessary for its due preservation.

The particular result of these trials, to which we would direct the attention of the worker in wood, is the great increase of strength which this treatment causes; this has been accurately determined at the different degrees of temperature, showing the remarkable fact, that timber may be thus improved in tensile strength to an immense extent. Elm obtains its maximum point of strength at a temperature between 150° and 175°, whilst that for the other woods varies from 125° to 150°. Ash receives an accession of two-thirds its original strength; oak, five-ninths; walnut, nearly one-half; fir, two-fifths; and elm more than one-third. The order of classification here given is according to that of the temperatures. It appears that the process condenses the fibres, and gives to the wood the properties of solidity and firmness, so much sought for in the material used for musical instruments, equalling an amount of seasoning of thirty or forty years.

ANATOMY OF THE PHYSICAL STRUCTURE OF THE UNIVERSE.

By Mr. R. Smith, Blackford.

III.—Light.

When we view an object through any transparent substance, the faces of which are parallel to each other, as a layer of water or a sheet of glass, its appearance is single, and in every respect the same as that which it presents in the open air without the interposition of any denser medium; but if seen through a rhomb or rhomboid of carbonate of lime (Iceland spar) a duplex representation occurs. In the first instance, we have an example of simple or single refraction; in the second, compound or double. When a mass of glass or water with parallel faces is unequally heated, so as to produce strata of various densities, such as in the artificial illustration of the mirage, it is not, as might be supposed, a case of double refraction, but is dependent upon the law of sines, discovered by Snellius; and, whether the object is doubled or tripled, it is merely

simple refraction, produced by the same power of attraction, only varying in intensity.

To exhibit double refraction, a rhomb of Iceland spar is placed above a narrow line, and on looking downwards upon its upper surface, we see two lines instead of one. Or, if a ray of light is made to fall upon the upper surface of the rhomb, it will be divided into two distinct rays issuing in a line with the plane of the base of the figure, consequently the ray has undergone double refraction in passing through crystal. The same phenomenon takes place when the ray is directed upon any other face of the crystal, showing that the double refraction is not caused by a difference in the density of the material through which it passes, as is the case with water unequally heated. Hence it follows that Iceland spar possesses the property of separation of the ray into two, the one being refracted according to the ordinary law, the other according to what is termed the extraordinary law.

Many other bodies, as artificial salts, mineral and vegetable substances, possess the power of double refraction. Others, again, do not possess this quality of themselves, but are capable of receiving it, either transiently or permanently, by certain processes. All double refracting bodies contain planes or lines in which there is no doubly refracting force. Such as are possessed of one plane of double refraction are termed crystals, or bodies with one axis of double refraction; those that have two or more are termed bodies with two or more axes, according to the number they contain.

When the ray of extraordinary refraction is refracted in the direction of the axis of a double refracting substance, it is termed a positive axis of double refraction; and when refracted from the axis, it obtains the name of a negative axis. The following is a list of crystals possessing the power of double refraction:—

Crystals possessing one Negative Axis of Double Refraction.

Iceland Spar.	Phosphate of Lead.
Tourmaline.	Phosphato-Arseniate of Lead.
Rubellite.	Phosphate of Lime.
Carbonate of Lime and Iron.	Subphosphate of Potass.
Carbonate of Zinc.	Phosphate of Ammonia and Magnesia.
Carbonate of Lime and Magnesia.	Sulphate of Nickel and Copper.
Cyanuret of Mercury.	Arseniate of Potass.
Muriate of Lime.	Hydrate of Strontites.
Nitrate of Soda.	Muriate of Strontia.
Alum Stone.	Levyne.
Sapphire.	Ruby Silver.
Cinnabar.	Corundum.
Emerald.	Ruby.
Nepheline.	Arseniate of Copper.
Mellite.	Beryl.
Prussiate of Potass.	Arseniate of Lead.
Wernerite.	Octohedrite.
Meionite.	Idocrase.
Somervillite.	Paranthine.
Mica with Amianthus.	Edingtonite.
Mica from Kariat.	Hyposulphate of Lime.

The following substances contain one positive axis of double refraction:—

Dioptase.	Ice.
Hydrate of Magnesia.	Quartz.
Oxide of Tin.	Zircon.
Titanite.	Tungstate of Lime.
Superacetate of Copper and Lime.	Apophyllite.
Beraeite.	Oxahverite.
	Sulphate of Potass and Iron.

When the force that produces double refraction emanates from the rhomb, that is, when the plane of incidence passes through its axis, the extraordinary ray is constantly in the same plane; but when the plane of incidence is inclined at any angle to the axis, the extraordinary ray is thrust out of its place or plane by the preceding force, as it would appear, from the axis, so that it is difficult to determine, either by calculation or projection, the exact proportion of the extraordinary ray. If the plane of incidence is in the equator of double refraction, that is, perpendicular to the axis, where the force is a maximum, then the extraordinary ray is continually in the plane of incidence, consequently its position may be easily determined at all angles of incidence in this plane, as if it were acted upon by an ordinary force, the refractive index of which is 1·6542. The same observations are applicable to all other crystals containing one negative axis.

Light emitted from luminous bodies, as the sun, or a candle, is termed heterogeneous, being composed of different colours. Every one has witnessed the remarkable and beautiful play of colours on the surface of crystallized bodies, such as mother of pearl, irregular surfaces of glass, ice, &c., which possess the power of exhibiting colours, although none exist in their own composition. If a beam of sun-light is admitted into a darkened room, and a prism is placed near its entrance, so that the rays fall upon its edge, a white screen behind the prism will receive an oblong image, made up of seven colours, red, orange, yellow, green, blue, indigo, and violet. This coloured image is termed the prismatic or solar spectrum. If it is divided into 360 parts, according to the experiments of Newton, the red will be found to occupy 45, the orange 27, the yellow 40, the green 60, the blue 60, the indigo 48, and the violet 80 parts.

The researches of Sir D. Brewster and Mr. D. R. Hay, have proved that in reality there are only three colours in the spectrum—red, blue, and yellow; and that the other colours are all compounds of these, the red and yellow shading or blending into each other where they meet, forming orange; yellow and blue, green; blue and red, violet, &c. If the rays of the spectrum are condensed or brought to a focus by means of a convex lens, the coloured rays form a white image.

The composition of light admits of further proof, by means of the simple experiment with the revolving coloured disc, which, if divided into sections, and coloured according to the proportions given in the spectrum, when rotating at a high degree of speed, exhibits a greyish-white surface. Of the colours of the spectrum the red is refracted least, and is found at the commencement of the spectrum, whilst the violet is subjected to the greatest refraction, and appears at the extremity. Beneath the ordinary red ray, there has been found another red of a deeper tint; and again, beyond this, by the aid of very delicate thermometers, rays have been detected which do not affect the organs of vision. Sensitive chemical compounds have also discovered the existence of other rays beyond the violet; but we leave this portion of the subject for future discussion, under the head of Photography.

Field has proved that the three homogeneous or primitive colours exist in white light, in the following proportions:—Yellow, 3; blue, 8; and red, 5; and accordingly when these colours are reflected in their respective proportions, from an opaque body, white is the result; for although each is in an active state, yet one neutralizes the other. Again, when their colours are similarly absorbed, their state is passive, and black is produced. According to the acknowledged theory, when light passes through a coloured medium, the rays corresponding with the colour of that medium are refracted or transmitted, whilst the others are absorbed.

The author has made extensive experiments on some of these points, and the results he has obtained do not confirm this opinion. A ray of light passing through yellow glass was directed by a prism upon a white screen, and the spectrum presented the same appearance as colourless light, except that the blue was changed to a green tint. When the ray was passed through a red and yellow glass in contact, the same result was given, but in fainter colours. Various other colours and densities were also tried without any difference in the result. Doubtless, when a ray is passed from a transparent medium into a denser one, part of the light is absorbed, and part reflected back; but, from the above-mentioned experiment, it is obvious that, whatever is the real nature of light, it certainly possesses the power of combining with the colour of the medium through which it passes—therefore the theory of the passage and absorption of colours, according to the colour of that medium, is not based upon fact.

MARINE MEMORANDA.

THE IRON STEAM TUG "WIZARD."

The Clyde has earned some fame by its steam tugs, a class of boats more for use than ornament, whose performances are not often chronicled. Improvement has been at work here as well as in other departments of marine engineering, and the growth and accession of experience is worth noting.

The "Wizard" was built and engine-fitted by Messrs. Scott and Sinclair of Greenock, and was launched in November last, her launching draught, forward, being 3 feet 7 inches; aft, 3 feet. Her keel is a flat bar, 5 inches by 2; stern and stern-post, 7 inches by 2; there are eight streaks of plates from keel to gunwale, tapering from $\frac{7}{16}$ to $\frac{1}{4}$ inch; rivets, $\frac{3}{4}$ to $\frac{5}{8}$ inch. She has one flush deck, one mast, sloop rigged, round sterned, and clinker built.

Dimensions—Hull.

Length on deck, N. M.	75 feet.
Ditto of engine-room	43 "
Midship breadth on deck,	14 "
Depth of hold	9 "
Tonnage—Hull	81 tons.
Engine-room content	60 "

She has a pair of side-lever engines; her paddles are on the principle of those made by Rennie and others on the Thames, with one central boss for the arms, which slope out on each side at a considerable angle, and are attached near the extremities of the floats as usual. The shaft has no outer bearing, but is carried by a beam projecting from the side of the vessel to within the angle of the paddle arms. The outer extremity of the shaft carries a light ring or boss, from which a set of stays is carried to the outer ends of the floats, as an additional means of steadiness.

Engines.

Nominal power	36 horses.
Diameter of cylinders	24 inches.
Length of stroke	3 ft. 6 inches.
Diameter of air-pumps	1 6
Length of sole-plate	11 $8\frac{7}{8}$
Breadth of ditto	2 6
Thickness ditto	0 $1\frac{1}{4}$
Depth of feather	0 $3\frac{1}{2}$ to $7\frac{1}{2}$
Depth of seats for columns	0 $9\frac{1}{2}$
Cylinder to main centre	4 $3\frac{3}{4}$
Main centre to air-pump	2 $5\frac{3}{4}$
Air-pump to crank-shaft	1 $10\frac{1}{8}$
Seats for columns, fore and aft, (centres)	2 0
Ditto transversely, ditto	1 $11\frac{3}{4}$

Side Levers, Cast-Iron.

Main centre to air-pump studs	2 ft. 7 inches.
Air-pump to studs for cross-tails	1 11
Main centre to studs for cylinders	4 6
Extreme centres	9 0
Diameter of eye, main centre	0 $11\frac{1}{2}$
Ditto air-pump studs	0 $4\frac{1}{2}$
Ditto at ends	0 $7\frac{1}{2}$
Depth at main centre	0 $17\frac{1}{2}$
Ditto at ends	0 $6\frac{1}{4}$
Breadth of flange	0 $3\frac{7}{8}$
Thickness of metal in web	0 $1\frac{1}{4}$
Diameter of main centre	0 $4\frac{1}{2}$
Length ditto	0 $9\frac{1}{2}$
Diameter of cross-tail and side-rod pins in ends of levers	0 $2\frac{1}{4}$
Length ditto ditto ditto	0 $2\frac{5}{8}$
Diameter of pins for air-pump side-rods	0 $1\frac{3}{4}$
Length ditto ditto ditto	0 $1\frac{15}{16}$
Main centre to sole-plate	0 $17\frac{3}{4}$
D. slide valves, stroke	0 $5\frac{1}{8}$
Throw of eccentric	0 $4\frac{1}{2}$
Diameter of brass hoop	0 $13\frac{1}{2}$
Length of steam ports	0 11
Depth ditto	0 2

Cranks.

Diameter of large eye	$11\frac{5}{16}$ inches.
Length ditto	$5\frac{5}{8}$
Diameter of small eye	$7\frac{7}{8}$
Length ditto	$4\frac{5}{8}$
Breadth of arm	9 to 6
Thickness ditto	$3\frac{7}{8}$ to $4\frac{1}{8}$
Diameter of crank-pin	4
Length ditto	$3\frac{3}{4}$

Crank-shaft and Paddles.

Diameter of crank-shaft journals	$5\frac{11}{16}$ inches.
Length ditto	$7\frac{1}{2}$
Diameter at ends	$4\frac{1}{4}$
Length ditto	6
Centre to centre of paddle-shaft journals	10 ft. 10
Diameter of shaft	$5\frac{3}{4}$
Ditto at paddle centres	$6\frac{3}{4}$
Diameter of paddles, extreme	13 ft. $5\frac{5}{8}$
Ditto effective	13 $0\frac{7}{8}$
Length of floats	7 ft. 0 inches.
Breadth ditto	1 4
Arms from centre	7
Sets of ditto	2
Number of floats	14

Piston-rods, Valve-rods, &c.

Diameter of piston-rod	3 inches.
Ditto valve-rods	$1\frac{1}{2}$
Ditto air pump-rods	$2\frac{1}{8}$
Ditto feed and bilge-plungers	$2\frac{1}{2}$
Ditto guide-rods	1
Ditto air-pump side-rods	$1\frac{1}{2}$ to 2
Ditto connecting-rods	$3\frac{1}{4}$ to $4\frac{1}{4}$
Ditto eccentric-rods	$1\frac{3}{4}$, 2 to 3
Ditto expansion-rods	$\frac{7}{8}$ to $1\frac{1}{2}$
Cylinder side-rods	$2\frac{1}{4}$, $2\frac{3}{4}$ to $3\frac{3}{4}$
Piston to side-rods (centres)	$18\frac{1}{2}$
Air-pump side-rods ditto	3 ft. $0\frac{1}{4}$
Slide-valve links	6

Air-Pump Cross Heads.

Bucket-rod to plungers	$10\frac{1}{2}$ inches.
Plunger to guide rods	3
Guide rods to side rods	9
Diameter of eye at bucket-rod	$3\frac{7}{16}$
Depth " "	$5\frac{1}{2}$
Diameter of eye at guide-rod	$2\frac{5}{8}$
Depth " "	$4\frac{1}{16}$
Diameter of eye at plungers	$2\frac{3}{8}$
Depth of ditto	$4\frac{1}{16}$
Depth of web	$2\frac{3}{4}$ to $4\frac{3}{8}$
Thickness	$1\frac{1}{16}$ to $1\frac{1}{2}$

Cylinder Cross-heads and Cross-tails.

Diameter of eye	$5\frac{5}{8}$ inches.
Depth of ditto	8
Depth of web	$3\frac{3}{4}$ to $7\frac{1}{8}$
Thickness	2 to $2\frac{1}{2}$
Cylinder side rods and guides	$5\frac{1}{16}$ to $3\frac{3}{16}$

Two Oval Boilers (common flue.)

Length	17 ft. $3\frac{3}{4}$ inches.
Breadth	5 2
Height	7 3
Length of steam chest	5 $1\frac{1}{2}$
Breadth	2 $5\frac{1}{2}$
Height	3 0
Two furnaces to each boiler, length	5 0
Breadth	1 $10\frac{3}{4}$
Height, including ash-pit	3 $7\frac{1}{4}$
Length of funnel	22 6
Diameter	2 $5\frac{1}{2}$

Her steam pressure is intended to be 20 lbs., making her engines 50 horse power. On a trial with some of the older tugs, she beat the "Samson," but was easily distanced by the "Gulliver." We have not sufficient information as to her towing powers, but believe they are of a superior order.

RECENT PATENT.

HEATON'S METHOD OF BALANCING THE RECIPROCATING PARTS OF LOCOMOTIVE ENGINES.

In our report of the proceedings of the Institution of Mechanical Engineers, which will be found in another page, honourable mention is made of the early exertions of Mr. George Heaton of Birmingham, to improve the working of general machinery, but more particularly locomotive engines, by balancing the different moving parts. His original intention was confined to the simple balancing of the wheels and heavy cranks, and the plans he proposed for this purpose have been successfully introduced on most of the railways of this country. Latterly, however, the high speeds which have been gradually attained, have led him to propose the balancing of the pistons and piston rods in their reciprocatory movements, which, in their unbalanced state, tell to so great an extent upon the working of the engine. Any one who has carefully noted the amount of motion between the engine and tender, when standing on the foot plate, will readily comprehend how large a portion of the oscillation is due to the movement of the unbalanced pistons, piston rods, and connect-

ing rods. At each stroke of the engine, the large body of metal in these parts being driven forward, causes a violent reaction of the whole engine; and to such an extent does this take place, that, as Mr. M'Connell has justly remarked, many of the cases of locomotives leaving the rails at high speeds have been attributed to it.

Mr. Heaton's plan consists in the attaching of a second connecting rod, similar to that of the driving crank, to an additional crank set directly opposite to that of the cylinder. This connecting rod passes along the framing of the engine in a direction exactly contrary to the working rod, and its opposite extremity is linked to a weight, which is suspended freely from loose links on the framing, so as to move with the least effort. The weight of the second connecting rod and the suspended mass being made exactly equivalent to that of the moving parts to be balanced, it follows that the momentum produced by the reciprocatory motion in working is thus completely neutralized, as the two acting forces are always diametrically opposite to each other. The idea is simple, and although it adds somewhat to the friction and dead weight of the engine, besides being no ornament, its effect is quite successful in steadying the engine.

Specification enrolled May, 1848.

RECENT AMERICAN PATENTS.

COMPOSITION FOR ADDING TO PAINTS.

ROBERT BRAMAN.

To make one gallon and a fourth of paint of a permanent and durable body:—Take one gallon of rain water, three pounds of gum shellac, three ounces of pearl ash, and put them into an iron vessel, and boil them slowly over a moderate fire without stirring them until the ingredients are well incorporated.

Claim.—"What I claim as my discovery, and desire to secure by letters patent, is the before-described composition to be added to paints ground in oil or otherwise, for producing the effects described."

PNEUMATIC SPRINGS FOR RAILROAD CARS.

JOHN LEWIS.

We make the following extract from the specification:—

"The nature of my invention consists in applying the elasticity of atmospheric air, or any permanently elastic gas, by means of an expanding and contracting chamber, or chambers, made in one, two, or more parts, and connected together by means of two or more belts of India-rubber cloth, or other flexible or impermeable material, with alcohol or other liquid interposed, the more effectually to prevent the escape of the air or gas contained in the apparatus, and to aid in relieving the flexible connexion, and preventing its rupture by the action of the weight or force on the spring; this mode of connecting two vessels being applicable, without the air, to other purposes, such as hydraulic presses, &c., by forcing water into or between the two vessels. And my improvement also consists in providing this apparatus with one or more of what I denominate a *respiratory chamber*, or chambers, attached to one or both ends of the apparatus, and separated from the main chamber of the apparatus by a diaphragm, or diaphragms, perforated with holes, which will check the passage of the air, and thus relieve the apparatus from the injurious effects of sudden shocks."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, first, the method of connecting the two vessels, composing the pneumatic spring, bumper, press, &c., by means of two or more belts, with alcohol or other liquid interposed, substantially as described, to be used for the purposes above set forth.

"Second: I claim so arranging the two vessels, and the connecting belt or belts, substantially as described, that the belt or belts shall, at all times, be sustained by either one or both of the vessels, to prevent them from being ruptured by the pressure of the contained fluid, as described.

"Third: I claim dividing the space between two discs into one or more spaces by means of a perforated diaphragm, or diaphragms, to form what I denominate a respiratory chamber, or chambers, substantially as described, and for the purposes explained above.

"Fourth: I also claim making the inner periphery of the outer vessel, or the outer periphery of the inner vessel, or both, beveled or conical, so that the space between the two, in which the flexure of the connecting belt or belts takes place, shall be diminished as the pressure increases, as described, for the purpose of enabling the flexible connexion the better to resist the increased pressure, as described; and this I claim, whether used with or without the other improvements."—*Franklin Journal.*

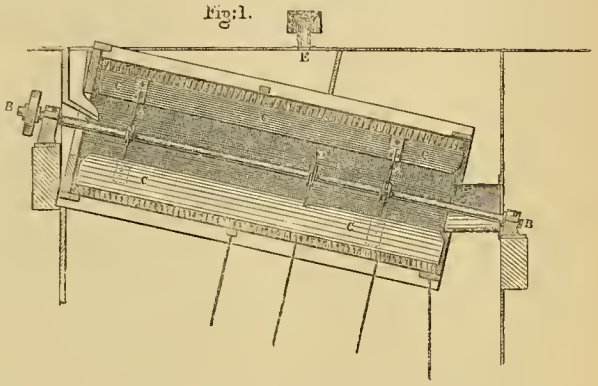
REGISTERED DESIGN.

FAN-BLAST FLOUR-DRESSING MACHINE.

Registered for W. SOUTHAM, *Nuneaton, Warwickshire.*

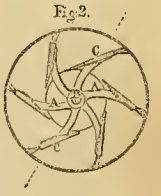
The principle involved in the construction of this machine, is the employment of a brush acting as a fan, for forcing the flour through the wire-work by an air-blast. The inventor says, "During an experience of 18 years as a miller, I have always found it a received opinion on the subject of flour-dressing machines, that the brushes are placed in the cylinder to brush the flour through the wire. This, I am convinced, is an error. From attentive observation, I have discovered that the machine is virtually neither more nor less than a blower, but an inefficient one." Following out this idea, Mr. Southam has constructed his brush so as to act exactly like a fan. Fig. 1 is a longitudinal section of the

Fig. 1.



dresser in working order. Fig. 2 is a corresponding transverse section of the same. A A, Are the curved arms carrying the fan-brush, springing from two bosses keyed on the inclined shaft, B B; C C, is the improved wide brush occupying one-third of the diameter of the cylinder. A central opening, one-third the diameter of the cylinder, is made in each end, as in the case of an ordinary blast-fan, for the entrance of the air, the up and down current of which is checked by a light disc, D, on the fan-shaft; E, is an air-vent into the hopper or meal-garner. The revolution of the fan-brush causes a rapid distribution of the meal upon the wire cylinder by the air pressure, the brushes themselves working close up to, but not actually in contact with, the wire surface. The facility of discharge also prevents the liability to burst the wire from overfeeding. A 20-inch cylinder, working at the rate of 400 revolutions per minute, dresses from 20 to 25 sacks per hour, with an expenditure of from 4 to 5 horses' power.

Fig. 2.



REVIEWS OF NEW BOOKS.

THE HIGH-PRESSURE STEAM-ENGINE, Parts 3 and 4. By Dr. Ernst Alban.—*(Second Notice.)*

In spite of the numerous ingenious features which Dr. Alban has worked up in his boiler, we do not think it stands much chance of being copied by engineers in this country. It is, to a certain extent, more complex than any arrangements at work here; and although he assures us that the results he has obtained warrant him in asserting its superiority, yet no direct statements of actual benefit are to be deduced from his pages.

His observations on furnaces, chimneys, and flues, contain some practical remarks of moment. He is an opponent of high chimneys, and states that he has often built them of a height less than 25 feet, with good results. In his arguments on this head, we find passages that would be amusing enough, were it not for our conviction of the prevalence of diseases resulting almost entirely from a smoky and noisome atmosphere.

"Chimneys of 80 to 100 feet, particularly in a roomy situation, are useless superfluities, involving the proprietors in unpardonable expense, and manifesting a want of experience in their contrivance, if the only object proposed to be attained by them is improvement of the draft. There are, however, other motives for such a measure; the principal of which is to avoid annoyance to the neighbourhood by smoke, an offence against the laws of many states. A height of less than 70 feet is enough for such a purpose. These laws regarding the nuisance of smoke from steam-engines are both unjust and impolitic. Many other cases where coal is burnt, particularly smithies and iron-works, are treated with less strictness, and indeed often passed over altogether. Why such obstacles should be thrown

in the way of the steam-engine is to me incomprehensible. We acknowledge that England has attained her present high grade of industrial culture by her steam-engines;—we complain often of continental inferiority in this particular; and yet we put a drag on our progression, lose sight of great and important objects through trivial considerations, and find that, from the highest quarters, where progression ought to be gladly encouraged, laws emanate which make advancement in science more shunned than promoted, and viewed with as much fear as reform in the political sphere. We are ever accustomed to attend more to a partial cry than to the voice of a universal need. We attach more importance to a little coal vapour than to that much higher and more glorious object, the power which the coal puts in our possession; and in order not to offend the noses or soil the linen of a few, we thwart the good of the many by endangering their highest interests. How would it fare with England if a little smoke brought about there such obstructions as it does in Germany? The English continue to live among their smoke, and find themselves well off in it too; they neither turn up their noses nor get asthma, but they live, and live long; for this smoke is the fruit of activity, and activity maintains the health and lengthens the life of man."

The Health of Towns Commission would be able to furnish the author with some opposition evidence on this point, showing him, that although we do live, and some of us live long, yet the tainted atmospheres of our manufacturing towns have a vast amount of disease and death to answer for. In the little manufacturing towns of the Continent, the evil of smoke is comparatively little felt, for many of them might almost be contained within the precincts of some of our giant factories; but how the Doctor could describe us as finding ourselves well off in our smoke, is more than we can well explain.

"A great mistake is often committed in making the fire-bars too strong, and the interstices between them too small, which hinders a proper supply of air to the fire. We shall not err in making the bars 1½ inch wide. In order to give them the necessary strength, they should have elliptic ribs projecting on their under side, to a depth of about 4 or 5 inches, dependent on the length of the bars: the rib should taper sharply on both sides like a comb, which will not only facilitate the penetration of air into the fire, but also allow conveniently the introduction of an instrument to clean out the interstices between the bars when they become stopped up with dirt or cinders. If the bars are long, it is advisable to cast lateral projections ½ inch wide in the middle of the bar, which may butt against each other when the bars are in their place, and prevent lateral bending. When the grate is required of considerable length, as 6 or 8 feet, the bars should be in two lengths, with a strong cast-iron bearer in the middle of the furnace, so supported as not to bend. Various rules have been laid down for the size of the interstices between the fire-bars; my experience, however, has given me the universal rule to make them under all circumstances half an inch wide. This width answers for all kinds of fuel, allowing but little to fall through, does not become easily stopped up, and admits conveniently of the introduction of the cleaning instrument. A good kind of bar is that with a concave upper surface; I have found that it really deserves the good character it generally bears. The concavity becomes filled with ashes, which, conducting heat badly, prevent the too rapid destruction of the bar by the fire. The best material for furnace-bars is cast iron; it is firmer, stronger, more durable, and cheaper than wrought iron, which soon becomes bent and destroyed. Bars of square wrought iron, laid with an angle upwards, are the worst of all. Hollow bars, through which water from the boiler flows, have been recommended, but do not answer. They are not durable, besides being productive of endless trouble."

Until within a year or two ago, this mistake was of very frequent occurrence, but the true construction is well enough understood now. Bars with a concave upper surface were made some years ago by Mr. Bodmer, then of Manchester; the Doctor says truly, when he mentions that they have earned a good character. Passing over a description of his own furnaces, we arrive at the main subject of the book—the engine itself. The oscillating engine is the one which has received the stamp of the Doctor's favour, and he proposes its adoption under all circumstances. The exploded objections of loss of power by the motion of the steam cylinder—unequal wear of the piston and stuffing-box—and the friction on the cylinder trunnions, are all taken up and handled with considerable ability. Fortunately, there is now little request for so stout an advocacy, as the oscillating cylinder is sufficiently well introduced to show the groundlessness of the theories urged against it. Contrary to what we should expect to find in the book, the hemp-packed piston is lauded as being immeasurably superior to the modern metallic one, thirteen distinct difficulties being brought forward as evidence against the latter. Whatever might have been said of the pistons of ten years back, when, it is stated, the body of the work before us was written, it is obvious that no such evils are to be charged against the single ring piston of modern engines, and we should needlessly take up our space by saying more about it.

The particular modification of engine recommended is the ordinary pendulous engine, almost identical with those made by Joyce of the Greenwich Iron-works, illustrated in our Parts 1 and 2. The framing consists of four Doric columns carrying a substantial rectangular top plate, from which the cylinder depends. As a means of avoiding the great friction on the cylinder trunnions, when heated by the passage through of the steam, a separate cast-iron plate is bolted to the top of the cylinder, with solid trunnions, upon which the cylinder oscillates, the steam being conducted into the valve-chest, which is on the top of the cylinder, by a vertical pipe passing up inside the trunnion frame, and curving inwards to a conical metallic joint in the line of the axes of the trunnions. The arrangement is very simple, but we doubt whether there is any real ground for this departure from the usual mode of construction. The valves are worked simply by the oscillation of the cylinder, so that one great point, the *lead*, is lost.

Part 4 is devoted to remarks on the consumption of fuel, with descriptions of varieties of engines constructed by the author. With reference to the economy of his engines, he says—

"I will first instance an engine which I had for two years under my own daily observation, in an iron foundry and machine manufactory in which I was a partner. The engine was nominally 3-horse power, and had a form like that sometimes called Maudslay's portable engine, but of course without the parts belonging to the condensation. The cylinder was 4½ inches in diameter in the clear, and had a stroke of 1 foot, and the engine was so light that, without the fly-wheel, it could be carried by two men. Its usual velocity was from 70 to 80 revolutions in a minute, dependent on the work it had to do. It drove the following machinery, viz.—Six lathes; three small and three large. One of these had a 7-inch spindle; and they had often heavy work upon them while all the under-mentioned machinery was in action. One grindstone One cylinder blowing machine for six smithy fires. This drew in regularly 200 to 220 cubic feet of air per minute at atmospheric pressure, and delivered it to the fires at a pressure of ½ lb. per square inch. Also, on casting days, a large blowing machine for the foundry, which drew in 700 cubic feet of air per minute, and blew it out again under a mean pressure of ⅝ lb. per square inch. The latter alone required, before the steam-engine was erected, the power of two large and strong horses, which were often foaming with perspiration during a work of only four or five hours. The power required to work the small blowing machine may be reckoned by the proportionate quantity of air drawn in; remembering, however, that the small machine had a greater relative amount of friction and prejudicial resistance to overcome than the large one. The blowing engine at the Royal Iron Foundry in Berlin, which only draws in 960 cubic feet per minute, and delivers it at ⅝ lb. pressure, has been estimated at 11 or 12-horse power. When, therefore, all the above work is considered, I do not think I estimate the power of the engine too high at 4-horse power. Now, with all this work upon it, it required only in fourteen hours 4½ Mecklenburg bushels of Newcastle small coal, weighing in a wet state 340 lbs., or dry at most 300 lbs. This gives the consumption of coal $\frac{300}{14 \times 4} = 5{\cdot}3$ lbs. per horse power per hour. I think this must be allowed to be an extraordinarily economical result for so small an engine."

This performance, if we take the duty as stated by the translator to be correct, is far from what good expansive engines are now doing; had an indicator been employed to guage its capabilities, we might have arrived at a clearer idea of its economy, but a comparison with actual horse's power shows nothing.

In closing the volume, we cannot help being struck with the originality of ideas to be found in its pages; and when it is remembered that it was written several years ago, before we had possessed ourselves of much experience on the bulk of the points therein treated of, the accuracy of the deductions is very striking.

To Professor Pole we are indebted for the superior manner in which he has treated the original; for, whilst he has preserved intact the expressions and general conclusions of his author, he has at the same time rendered him important service in the re-arrangement of the matter. To Mr. Weale is due some acknowledgment for the admirable manner in which the volumes are got up, and to Mr. Gladwin for the beauty and extreme accuracy of the numerous plates which adorn it.

Report to the Directors of the Manchester, Sheffield, and Lincolnshire Railway, on the Supply of Water to Manchester and Salford, by means of the Surplus Water Act of that Company; with Remarks upon the Construction of Rain-Guages, and the Annual Depth of Rain falling in different localities around Manchester. By S. C. Homersham, C. E. 8vo. Pp. 88. Plates. London: Weale. 1848.

For some years past, Manchester has suffered from the strife of water companies, and, in the heat of the conflict, has been put on short allowance of water. Three distinct bodies—the Manchester and Salford Water Works Company, the City Corporation, and the Manchester, Sheffield, and Lincolnshire Railway Company—have tendered their services, each elbowing back the other; but the abundance of promises has, up to this time, been backed by scanty performances, and Manchester yet thirsts for a pure water supply.

The present Water Works Company derive their supply partly from two reservoirs situated at Gorton, a short distance east of Manchester, and partly from a reservoir at Beswick, eked out by a well sunk in the red sandstone, near Gorton. Added to these sources, the Peak Forest Canal has for three or four years been called into use for the same purpose; and it is this application of it which Mr. Homersham, as the professional adviser of the present proprietors of the canal, the Manchester, Sheffield, and Lincolnshire Railway Company, advocates in the book before us. In order to comprehend the state of the country round Manchester, as affecting its drainage, let us take the author's description:—

"The town of Manchester is situated at an average height of about 120 feet above the mean level of the sea at Liverpool, and is bordered on the north-west, the north, the east, and the south, by high hills and upland, that, in a distance varying from twelve to eighteen miles from the town, rise 1100 to 1900 feet above the sea, when they begin to fall in a contrary direction. The highest points in this range of hills are Rivington Pike, to the north-west of Manchester, 1545 feet above the mean level of the sea; Blackstone Edge, to the north-east, about 1450 feet; Holme Moss, to the east, about 1859 feet; Kinder Scout, to the south-east, about 1981 feet; Axe Edge, south-east by south, 1751 feet; and Bosley-Minns, nearly direct south, about 1260 feet. These hills rise very abruptly, and the numerous valleys and mountain gorges that intersect them in various directions contain channels, called rivers or streams, that drain off the rain which falls upon them. The names of the principal rivers deriving their waters from the sources now pointed out, are the Irwell, the Irk, the Medlock, the Tame, the Etherow, the Goyt, the Dane, and the Bollin. The waters of the whole of these rivers unite in the river Mersey, and by this channel are discharged into the sea at Liverpool.

"The rivers upon which the towns of Manchester and Salford are situated, are the Irwell, the Irk, and the Medlock; the two latter streams joining the Irwell within the town. The area of land upon which the rain falls that feeds these streams before entering Man-

chester is about 163,000 statute acres; of which about 11,300 drain into the river Medlock; 17,000 into the Irk; and 134,700 into the Irwell: these rivers, like all others having a similar origin, are very irregular as regards the quantity of water which passes down them at different seasons. After a continuance of wet weather, the rains flow off the ground immediately after reaching it; the streams are of course soon swollen, and the quantity of water passing down them in a few hours, is often as much as in dry seasons will pass off in as many weeks or months. These floods, though chiefly of short duration, frequently do considerable mischief (as was the case last year, when the Medlock overflowed in Manchester and inundated Little Ireland), and they are now more sudden and violent than formerly, owing to the great improvement recently made in the drainage of land for agricultural purposes. The courses of the tributaries of the rivers that pass through Manchester, are shown on the accompanying map; and these streams are very remarkable for the many useful purposes to which they are applied. They are made to turn innumerable water-wheels, that give motion to machinery of various kinds; they are used to supply both the means of forming and condensing steam, that, properly directed, performs such a prodigy of labour with unceasing and untiring effect; they are used to scour, bleach, and dye the goods they have helped to spin and weave; and their flood-waters, collected in reservoirs, feed with water the canals and rivers that transport both the raw and manufactured material. They supply our houses with water for domestic purposes, and they perform the office of scavenger; removing from our dwellings the excretion and filth, that, remaining near us, would undermine our health, engender fevers, and cause premature death. If we examine the sources of the river Medlock, and notice the number of offices the water of this stream now performs, besides receiving a great portion of the drainage of the town of Oldham, we shall be satisfied that henceforth no wholesome water can be procured from it for the supply of Manchester; and we shall also be convinced, that what is now collected from it in flood seasons for the town's supply must be eventually abandoned."

The excellent map of the upland forming the sources of the different rivers and streamlets, with the amount of drainage surface to each, gives us a very clear idea of the various localities whence water may be obtained; and our own personal observations have given us some insight as to the nature and general suitableness of a good part of the ground in question. The surface draining into the Gorton reservoirs we know to be pretty densely inhabited: it is partly moss land, and the cultivated portion is annually spread over with filth in the shape of manure. Mr. Homersham gives a detailed statement of the main contents of the ground, which consist of 399 dwelling-houses, 40 farm-houses, 5 mills, a weaving shop, a dye-work, and a large Moravian boarding-school. Little more need be urged against this source of supply, and any one who has seen the Medlock, than which there is not a more wretchedly filthy stream in the kingdom, will at once admit the pressing necessity for a change in these fountains of supply.

The scheme which the Corporation have in view is the employment of the top portion of the drainage ground of the river Etherow, which, to its junction with the Goyt, consists of about 36,000 statute acres. Of this area it is proposed to take in 18,000 acres of the valley of Longdendale as drainage surface, by constructing five impounding reservoirs, of a collective content of something less than 600,000,000 cubic feet. To follow out this idea, a tunnel of a mile and a-half in length would have to be construeted through a hill near Mottram, and, before the town's supply could be taken, the large amount of 75 cubic feet per second would have to be provided for the mill-owners on the streams for every working day of twelve hours. About two-thirds of this surface is covered with peat, or decayed vegetable matter, which discolours the water to a very great extent; and, according to Mr. Homersham, such discoloration cannot be got rid of even by filtration, as a good deal of the vegetable matter is held in chemical solution. Added to this, the plan would require some years to put it in proper train, whereas the Peak Forest scheme could give an immediate supply. Mr. Homersham thus describes the scheme:—

"Referring to the accompanying map, about eight miles south-east of Manchester, the summit level of the Macclesfield canal will be found, stretching to the south, along the side of a ridge of high hills, and extending from Marple to Bosley, a little beyond Macclesfield. The top level of this canal is more than sixteen miles in length, without the interruption of a lock; and at Marple it joins the summit level of the Peak Forest canal, which stretches for about eight miles, in a south-easterly direction, along another side of the same ridge of hills to Whaley. The top level of both these canals are of the same height, being situated at an elevation of about 520 feet above the mean level of the sea at Liverpool, or 389 feet above Brown Street, Manchester: both canals are thirty feet wide at the top, and five feet deep, and are constructed in the most substantial manner. The Peak Forest canal proceeds down a series of sixteen locks from Marple, in a northerly direction, to join the Ashton canal, which connects Ashton with Manchester; and the Macclesfield canal proceeds, down a series of locks, from Bosley, a little beyond Macclesfield, in a southerly direction, to join the Trent and Mersey canal that communicates with Liverpool and the Midland Counties. To supply with water the locks of the Peak Forest and the Macclesfield canals, the Company are empowered, by Act of Parliament, to collect and impound the flood-water flowing down certain streams, which are fed from the rain that falls on an area of ground that will be found on the accompanying map, coloured green; reservoirs have been constructed to impound this water, and two will be found, coloured blue, near Bosley, which have been made and used for a series of years to supply the locks of the Macclesfield canal. Near Whaley, at the south end of the Peak Forest canal, two other reservoirs, also coloured blue, will be found, which have been made and used for a series of years to supply the locks of the Peak Forest canal; the Company have also powers to construct another reservoir on the Hockham brook, to the east of Whaley, for the use of this canal, and they collect certain water from the Reddicar brook that is not at present impounded in a reservoir, but runs into the Macclesfield canal about four miles south of Marple; in addition to this, all the water flowing off a large area of land from the hill-sides, along which these canals wind their course, finds its way into the canals."

After listening to the weighty objections urged against the opposition schemes, the substitution of canal water sounds rather strangely, especially when its purity is so stoutly insisted upon as we here find it:—

"The Company are not empowered to collect the *whole* of the water which flows off the hill-sides, and finds its way down the streams, near which their reservoirs are situated; on the contrary, in dry seasons, and at such times as the quantity of water flowing down the streams at a given point, will flow through a given-sized orifice, called a guage, the whole of the water passes down the stream to the mill-owners; but when continued or heavy rains cause the streams to be swollen, then the whole of the water that will not pass through such guage is impounded above the guage in a reservoir constructed for the purpose, and such water, so impounded, belongs to the Company. This system of collecting water is very favourable to its *purity*, as when it flows off the hill-sides during heavy rains (except in a peaty or boggy district) it is much less contaminated than water (percolating slowly from the soil, and reduced in quantity by evaporation) which forms the streams in dry weather; besides, over most large tracts of land, consisting of thousands of acres, there will be found farm-houses and a considerable resident population, and all the excretion and filth created from these sources, with the soluble parts of manures placed on the land, must, of necessity, drain into the streams, and tend to foul them in comparatively dry weather, although, in heavy rains and floods, the water is not perceptibly soiled from these impurities."

This is something new in the science of water impounding, as, according to the general practice of engineers, flood waters are always refused admission to the reservoirs, on account of the great amount of foreign matter they contain. The author himself acknowledges, that there is something objectionable at the first sound of conveying water by means of a canal, but urges its freedom from contaminating sewers, and the constant passage through it of a vast bulk of fresh water. We agree with him, however, that whatever objectionable features may present themselves on the score of the impurities arising from the navigation, they sink into nothing when compared with the actual abominations to be found in the water of the works now in operation.

In the Appendix of the work is contained some valuable information on the fall of rain, and the guages employed in measuring the amount, showing that a great amount of misconception as to the construction of guages and their modes of application, exists even amongst men of high scientific pretensions. The Literary and Philosophical Society of Manchester have been in the habit of using a cylinder guage, with a float and projecting index-rod, not remembering that the great surface of the rod would afford room for a derangement of the results, from the rain falling upon it. This has been clearly proved by a staff guage, put up by Mr. Wood, the resident engineer of the Peak Forest Company, where the staff, half an-inch in diameter and twelve inches high, collected as much as 22 inches of water per annum, in a cylinder seven inches diameter.

Mr. Homersham's book will be read with interest by engineers who are interested in hydraulic works; and, making due allowance for his zealous exertions on behalf of the company whose cause he espouses, we have every reason for placing reliance upon his general statements.

THE CAUSES AND EFFECTS OF EXPLOSIONS IN STEAM-ENGINES INVESTIGATED. By John Wilder. Pp. 26. New York: Taylor, Nassau Street. 1847.

The drift of this pamphlet will be best explained by the remainder of its lengthy title, which goes on to state that it contains a demonstration of "their result from an explosive principle different from the force of elastic steam; and conclusive evidence that more than four-fifths of the weight and strength of the engine are required to sustain their explosive force: with an easy and certain means of preventing its destructive effects, and reducing in great part the enormous weight of the engine." This big title promises a vast deal for so small a book—more, indeed, than would appear to be compressible within the space of its 26 pages. He commences with a catalogue of cases of explosion, and relates some curious facts bearing upon these occurrences, which are unhappily so frequent in America. His standard of the strength of the parts of engines is peculiar to himself: he rates the strength of the beam, cranks, shafts, &c., by the amount of pressure per square inch which they are capable of resisting. Thus, the Atlantic, which exploded on her passage for New York in 1846, was "fully equal to a force of 500 lbs. on every square inch of the area of her piston, which does not exceed the average strength of machinery in the best boats latterly built." Again, the Washington, which was to perform such feats of speed, is "equal to a force of more than 700 lbs. on every square inch of the area of her pistons. The prodigious weight and strength of her machinery are evident from her being advertised for 300 tons only of freight, to a burthen of 1750 tons; leaving more than 1400 for the machinery and fuel, in proportions not very unequal." From this, he argues that the power which breaks cranks, shafts, and beams of so great a strength cannot proceed from the boiler, but must originate in the valve-chamber and cylinder.

In place of there being but a single known cause adequate to the production of such a power, as he tells us, engineers are well aware that there are many. Did Mr. Wilder never hear of fractures in cranks and beams from the presence of water in the cylinder or valve-chambers? or from something going wrong with the valve gear, when the impetus of the engine is its own destruction? or the occurrence of a shock from a heavy sea?

We, in England, are not accustomed to the proportioning of the parts of our steam-engines to any given pressure in the cylinder. It is not the mere straightforward steam pressure against which we have to guard, but the thousand and one chance occurrences of shocks and casualties

unthought of until seen. The following will exhibit the line of reasoning of our author:—

"At high temperatures, the combination of water and caloric in the form termed steam, is so very slight that it can only be continued in close and strong vessels, and under a consequent strong pressure. This combination ceases instantaneously if the pressure be suddenly removed; nor, after the separation, can the constituents be recombined by any known means without previous reduction. If, therefore, the steam in an engine boiler be of a high temperature, and the steam valve be suddenly opened, steam will rush into the valve chamber, part of its caloric separating, from the partial removal of the pressure, and passing in first from its immense velocity, but there is no passage for its farther escape; and it may react or produce by its own inherent power the explosive phenomena which have been often observed, but not traced to their real cause, nor their analogy or extent properly estimated. When fire-arms properly loaded are discharged, the wad or ball traverses the bore of the piece with a motion much slower than the initial velocity of the gas liberated by the combustion of the powder; the gas is, therefore, under a degree of compression which keeps its constituents in combination until they leave the chamber of the gun, when they separate instantaneously; but if there be a space or interval between the powder and the wad or ball, the piece will burst, and the more certainly as the interval is greater."

This instance of the bursting of a gun when its muzzle is fastened up, is an unfortunate example for his theory. It is not necessary to point out how the abstract force of the powder is quite sufficient to produce the fracture, without calling in any other agent to account for it.

After following Mr. Wilder throughout his book, we cannot find anything in the shape of the "proof" of the causes of explosions, upon which he plumes himself so much. Here and there he darkly hints at electricity, but we find no tangible mention of it. His system of management of steam is peculiarly novel; he would keep it close, so as to prevent the escape of "elementary caloric." It is no easy matter to define his meaning in keeping it close. If the results of steam-engine management in America are in any way to be attributed to such a system, we cannot too closely avoid it.

A Comparative Account and Delineation of Railway Engine and Carriage Wheels. By H. B. Barlow. 8vo. Pp. 51. 1 Plate. London: Weale. 1848.

This book is unlucky in its title. Who would fancy that "a comparative account and delineation" had reference to a simple enumerative catalogue of railway wheels of all classes? Mr. Barlow informs us in his introduction, that he "does not profess to enumerate all the wheels that have ever been made—that would be impossible; he has, however, collected and arranged all those that have been published in the Repertory of Arts, the London Journal, and several other periodicals, in addition to many obtained from private sources." A large and well-executed lithograph presents elevations and sections of nearly 80 different wheels, beginning with Mr. Hawks' patent of 1807.

We could have wished that the descriptive matter had been more of a practical nature, and that some data as to the working of the modern wheels had been given. As it is, we have nothing more than a bare detail of their general construction, and are left to form our own opinions as to their economy and durability. In the arrangement of the figures on the lithographed sheet, we notice a great defect in the position of each as regards its date. Unless there were other controlling circumstances, which we do not see, each wheel should have taken up a position according to its date of introduction. This does not appear to have been well attended to. Engineers and intending patentees will find the volume of considerable service in showing what has been done in wheels, as it will save a great amount of searching through the pages of those works whence the examples have been principally culled.

We observe that, in different instances, the author has acknowledged the source to which he has been obliged for his matter; and we may hint to him that the drawing and description of fig. 95—the T iron wheel of Mr. R. Stephenson—were prepared by ourselves in 1845, and published in the Practical Mechanic and Engineer's Magazine in July of that year. The immense amount of information scattered through the periodical, and other works of this country, would afford ample material for compilations on an extension of the plan here laid down by Mr. Barlow. Valves, governors, rails, and the different tools, may be instanced as valuable subjects for descriptive volumes. It is not mere description, but the digested experience of practical men, that is wanted; and Mr. Barlow will do well to bear this in mind, if he contemplates carrying out what he has so laboriously begun.

Electrical Condition Applied to Facts, Connected with Heat, Crystallization, Meteorology, Evaporation, Magnetic Condition of the Earth, Gravitation, Chemical Affinity, Respiration, Ventilation, Constitution of the Atmosphere, Agriculture and Geology. By Franklin Coxworthy. London: G. Pierce. 1848.

In the present transitionary state of our information upon the phenomena of light, heat, electricity, and magnetism, the prevailing opinion is, that they are all attributable to one source, and every discovery of importance assists in the confirmation of this theory. Mr. Coxworthy has here advanced upon new ground, and argues that cold as well as heat owes its origin to electricity; cold being the positive, and heat the negative condition of electrical matter. After citing a number of atmospheric electrical experiments by Dr. Wells, Messrs. Cross, Weekes, and others, in support of this opinion, he observes, that "the evidence of cold being nothing but an electrical condition, may be traced in all natural phenomena, and the application of this property to electricity at once establishes a connecting link between all the sciences, and cannot fail in throwing much light on gravitation, the magnetic condition of the earth, the electrical condition of bodies, and on meteorology; all of which branches of science are, we conceive, inseparably connected with a philosophical inquiry into the original formation and present constitution of the globe."

For the complete establishment of this hypothesis, it may be observed, that a very considerable amount of practical data is required, in fact, to a far greater extent than the author, or any other philosopher, has yet been able to lay before us. The "applications" herein laid down will be read with the greatest interest by inquirers into the subject, the majority of whom will doubtless agree with us in thinking, that the suggestions held out may shadow forth more important matters than such as they directly indicate. We may probably again bear Mr. Coxworthy company at an early date, when time and space permits.

CORRESPONDENCE.

CRADDOCK'S IMPROVEMENTS IN THE STEAM-ENGINE.

I perceive, in the numbers of your Journal for May and June, that you have inserted two notices of the "Chemistry of the Steam Engine Practically Considered." I beg to thank you for the spirit in which those notices are written. That you should be sceptical upon some parts of my invention, was nothing more than what, from long and painful experience, I was prepared for, and which, as it would seem, ever attends inventions such as the one under review. It is the great misfortune of those who invent and realize extensive improvements in any department, but especially so in the steam-engine. That such improvements, from their very comprehensiveness, should have most to combat with prejudice, is what may be expected; but formidable as is mere prejudice to the introduction of such improvements, yet the inventor's greatest obstacles arise from the interested and the envious spirit which so successfully wields such prejudice to the retarding, if not suppressing, the beneficial results which mankind at large should derive from such improvements. We can thus easily understand how it has hitherto happened, that those who have most served mankind by their inventive powers have been the worst used. As those who make any comprehensive and original discovery must shock the preconceived notions of mankind, must excite envy, and break in upon the corporate spirit and the class interests of parties, I therefore take the liberty to affirm, that these are the great obstacles to the introduction of the invention before us, and not its assumed complexity, as a slight acquaintance with the practical working of such engines will satisfy any one that it possesses the advantages I claim for it. In a production of human ingenuity, such as I found the steam-engine on first turning my attention to it, which had all its primary principles, as it were, well nigh exhausted—so much so, that it was said to be useless to think of much further improving it—it appeared to me that the expansive property of steam was the only source from which it had derived its motive power, and that this principle was then but very partially developed; nor could it be otherwise, for the want of the following essential primary conditions, viz. a means of universal condensation of the steam with the production of a vacuum; the retention of the same pure water, so as to prevent deposit; boiler constructed on such principles as to be perfectly safe, for generating steam under greater pressure than prudence would warrant in the common boiler; and the engine so constructed as to work such high-pressure steam to the fullest extent expansively. Out of these primary requirements arose the following, which are of a secondary character, viz. that tubular boilers, owing to the much less water they contain, generate steam with much less regularity of pressure than the common boiler. To meet this difficulty the regulating damper is introduced, which is simple in construction and effective in operation. Secondly, owing to the more confined space in which the steam is generated in tubular boilers, there is a greater tendency to priming. The manner in which the steam-chest is fixed completely removes this objection. Thirdly, to work steam to the fullest extent expansively, it must of necessity, if one cylinder be used, impel the piston with such a force, at the commencement of the stroke, as to render the cylinder, piston, connecting rod, and main shaft unnecessarily heavy and inconveniently bulky; besides, the motion would be a very irregular

one. The two cylinders, as arranged and seen in the drawings illustrative of this invention, remove this objection, and are constructed, I may safely affirm, with as much simplicity as any can lay claim to. In using steam expansively in two cylinders, the obvious objection occurs, that on the steam quitting the first piston, previous to its impinging upon the second, it must necessarily fill the intervening space; consequently, we do not find it at the same pressure on its first impinging upon the second piston as on the termination of the stroke of the first. This is clearly illustrated by the curve of the indicator figure; the loss corresponds with the space between the two pistons, which must be occupied by the steam. To reduce this loss to the smallest amount, my steam valve was constructed. The expansive valve is introduced for the purpose of varying the power of the engine at pleasure. The means of adjusting it to any degree of expansion will not be outdone, either in the efficiency or simplicity with which it effects the purpose, as it readily enables the engineer to cut off the steam at one-hundredth part of the stroke, or work full pressure; and this too with as much facility whilst the engine is in motion as when standing still. I have thus, sir, briefly touched upon the principles brought into play by the invention, and the mechanical contrivances by which such principles are rendered—nay, proved to be—practically valuable, beyond the doubt of any who will investigate them in actual operation. They are not mere crude ideas, which a breath may make and destroy, nor simply the result of what speculation may assume or disprove. Speaking of engines of 20 horse power, with air as the medium of condensation, you are right in stating the power to work the condenser to be 5 per cent. or one horse power, but a condenser of 40 horse power takes but little if any more than one horse power to work it; therefore, the larger the engine, the less becomes the per centage of power required to work the condenser, whilst, with the condenser in water, it would not take half as much power to work it as in the air. You say, in your first notice, that my own experiments show that steam is condensed 25 times quicker when water is the medium of condensation, than when air is employed, and you conclude the sentence in the following words:—"He has then this enormous balance to outweigh before the air condenser can be placed side by side with its rival." As I never yet dreamed of condensing with air where water can be obtained, the air condenser I propose and use has no rival. But that the mode by which I condense with water will prove ere long more valuable than the rival to which you allude, I have the best of evidence, in its giving us pure water, rendering tubular boilers practicable and safe, and thus producing economy in steam navigation greater that has hitherto been dreamed of. What the invention will do when fairly carried out, I have, I trust, clearly shown in the tables I have appended to the work you have received, and sure I am that it will realize a saving equal to twenty millions sterling annually on the whole steam power of Great Britain. With these few remarks, I conclude, in the same tenor in which I began, by assuring you that the spirit in which you have reviewed the subject is such as deserves and commands my thanks. As I claim the right of individual judgment myself, I am quite free to award the same to all mankind. THOS. CRADDOCK.

Birmingham, June 22, 1848.

[Mr. Craddock is perfectly right in stating, that an investigation into the practical operation of his engines is the one thing needful for the formation of a just opinion upon their merits. Possibly we may one day have the opportunity of a personal examination of them, when we shall have more to say upon the subject.]

ON THE FORMATION OF COAL.

I have been pleased with the inquiries you have started upon the formation of coal, and have scanned what has been brought forward upon the subject in your columns; but it appears to me that we should ascertain certain points connected with the subject, as preliminaries and facts relating to it, before we begin to argue. Allow me to notice one in the right direction, and I will give you a few others shortly; thus we may help on this investigation.

We know that coal generally possesses a crystalline form; let us ask the question, how it could obtain this, if its origin was from wood? In the first place, we know that no substance can obtain a crystalline form unless it has assumed a liquid state; whether this state is produced by heat or solution matters not—at a certain degree of temperature only the crystallization takes place; therefore, coal has been liquefied by some agency or other. Of this there can be no doubt, and on this fact our inquiries must begin. Now, if coal is formed from wood, then the wood must have been rendered soluble or liquid; and whether this took place under the great pressure of the superincumbent mass, by the action of some chemical agent, or whether it was acted upon by heat, under the above circumstances, remains to be proved. The question may be considered under both views, and the chemist and geologist have an inquiry concerning the formation of coal under a new feature.

Let, therefore, the peculiarities of the position of coal, its attendant fossils, its composition, and the fact that it has been in a liquid state, be observed, and something new may be expected in the inductive philosophy connected with the subject. G. R. B.

Glasgow.

DECIMAL SYSTEM OF CURRENCY.

Your readers will be glad to see that an article on decimal currency has been favoured with a place in your pages, and as the subject is interesting to all concerned in calculation, I hope the following remarks will not be inappropriate. Your correspondent "Jacia," in your Journal for June, appears to me to have taken an expensive, abrupt, and roundabout mode to introduce a decimal money system, for it is not at all probable, as he proposed, that Government will make any alteration in our present gold and silver coins, merely to retain the copper for a new basis; for the latter, at present, bears a very slight value to the former, and consequently, it is more reasonable to suppose that they will retain the present gold and silver, and change the copper to suit them decimally. My object, however, is to point out a mode by which all our present currency may be retained, and yet be decimally arranged. To do this, I have to admit that a small loss, on the copper coins only, of a half-penny per twelvepence, or $4\frac{1}{6}$ per cent., will be sustained by those who hold copper at the first starting, and pay it away, when equal to one or more sixpences, in place of silver; but it is not common to pay any large amount in copper alone, so that probably the public would rather submit to a small first loss only on the copper, and retain the present coins, than have new ones introduced, to which they are unaccustomed, besides the great perplexity they would occasion to a large mass of the people for a long time to come. To effect this decimal arrangement then, it is only necessary that the sovereign, or value in silver coins, be declared to contain 1000 of our present farthings, or 250 of our present pennies; and of course the crown piece, 250; half-crown piece, 125; two shilling piece, 100; one shilling piece, 50; and sixpenny piece, 25 farthings; or their respective values in the smaller silver pieces, being one farthing extra in copper on each sixpence of value in silver. The small silver coins under sixpence, however, when *not* in amount equal to one or more sixpences, to pass for their value in copper as at present, in order to do away with a small fraction, which cannot practically be reckoned under sixpence: for example, $1\frac{1}{2}$d. silver piece is 6 farthings; but four of these pieces being equal to sixpence, are then to count 26 farthings, not 24, in order to make the extra farthing for the sixpence of value in silver as formerly stated, by which means the following decimal system is constructed:—

						Unit.	Decem.	Cent.	Mille.
1 farthing	or	¼ pence	...	...	... a Mille	£0	0	0	1
10 "	"	2½ "	...	...	... a Cent	0	0	1	0
100 "	"	25 "	or 2s. in silver	...	a Decem	0	1	0	0
1000 "	"	250 "	" 20s. "	or sovereign,	a Unit	1	0	0	0
1111		277¾			=	£1	1	1	1

I have used new decimal names expressive of their value relative to the sovereign, as the unit, and therefore more appropriate than "Jacia's" sol, dent, and libra. The names, however, as he justly remarks, are immaterial; but were the Mint to issue $2\frac{1}{2}$d. pence pieces, or rather the tenth part of a two shilling piece, there would then be distinct coins to represent all these new denominations, the two shilling piece being about to be issued. It will be observed, that four money columns are here used, but it is easily perceived, as "Jacia" also remarked, that one, two, or three may be used instead as found convenient; for our present system, strictly speaking, requires four columns, although three only are in use, the pence and farthings being conjoined, in consequence of the latter being expressed in a fraction of the former; and in like manner, the cent and mille columns may also be conjoined to suit our present money column books, the summation throughout being common or simple addition, not compound, as at present.

July 14, 1848. J. L. M.

DECIMAL SYSTEM OF CURRENCY.

The indulgence you have hitherto given me, encourages me to send you another paper on decimal currency. I intend in it to furnish you and your readers with my views on the practicability, advisability, and advantages of the system.

The first thing to be done, provided Government sanctions its intro-

duction, is to invent a new and appropriate nomenclature for the coins; which must be at once distinct from existing coins, and as significant as possible. Considering the great latitude there is here for invention, I think it may not be amiss to publish a series of my own, which, at all events, is classical and expressive of the values of the coins. Let the farthing be called a *unum* (one), the next coin a *decem* (ten), the next a *centum* (one hundred), and the gold piece a *mille* (one thousand). These words are the Latin numerals for the numbers in brackets, so that each will express the quantity of *farthings* or *unums* the coin contains. Every coin should contain the profile of her Majesty on the obverse, with the year, &c.; while on the reverse, there should only be the name of the coin and its value, with the year that the decimal coinage was introduced. The *decem* can be made either of copper, the weight of two pence and one halfpenny, or of silver, the same size as our fourpenny piece, but thinner. The fractional coins may be as numerous as is thought necessary, but should partake of the same characteristics as the *four fundamental coins*. But if it be thought desirable to honour royalty by calling these new coins by royal names, here is the plan: call the *unum*, a *farthing;* the *decem*, a *noble;* the *centum*, an *Albert;* and the *mille*, a *Victoria*. These are fine names; and, moreover, will perpetuate the name of the reigning sovereign in whose reign decimal coins were introduced into England. However, I prefer the plain sensible Latin names.

A system based upon the present might be established, but it can only be by a derangement in copper coins; which I consider most injudicious as well as unnecessary. But even then, before accounts can be kept in decimals, the whole series of coins must be issued. It is of no use coining two shilling pieces alone; because with them, sums of money cannot be represented decimally. In such a case as this, we must, to use the American phrase, "go the whole hog." Were I king of Great Britain (and I do earnestly covet that dignity for this one purpose), my first measure should be to introduce a decimal currency into my kingdom. If my advisers were to tell me "it cannot be done," I should plainly, but firmly say to them, "I am so well convinced that it will be for the benefit of the whole nation, that I say it can be done, it shall be done, and it must be done." Had I the power, I would revolutionize so far as to abolish the system of £ s. d., and would immediately establish some such decimal system. The French, and many other nations can boast of one; then why shall England, that "bless'd isle", still remain without such a possession? Every minute it is delayed causes an immense loss to the people; for is it not a loss to waste time—to be two hours in doing what might be done in one?

The great object then designed by the advocates of my system is, a simpler and easier method of reckoning and keeping accounts, by which much time will be saved, both to the learner at school, when first practising arithmetic, and to the grown-up man, when required to put that knowledge into practice. Arithmetic may be compared to an intricate machine; and of course the nicer this can be adjusted, and the simpler it can be made, the quicker and better will its movements be. The great advantage of machinery, so well set forth by Babbage, is a *saving of time*. This, as has now been fully proved and admitted by all classes, constitutes the present advantages of our country; for it is by the aid of machinery that she has arrived at her present proud position. For this reason, any new and useful machine is always joyfully received now, and not destroyed as formerly. So may we hope it will be with decimal currency. We wish each individual and every class to be made aware of its merits; for then, indeed, may we anticipate a general cry aloud, that shall reach even the ears of Government.

The first step to be taken is to bring it before the notice of influential parties, especially men of business, and those well acquainted with book-keeping or accounts. But until decimal coins are struck and circulated, decimal accounts or arithmetic cannot be used. It is not so much new coins we want, as an improved method of working and keeping accounts; decimal coins will naturally lead to decimal arithmetic, the simplest and best system ever devised.

One alteration required, is the issuing of new bank notes, because the present notes representing pounds can only be worth pounds; whereas, the new gold pound being worth £1 0 10, it would not answer to pay old notes in new pounds. The initial of the new coin must be substituted for the £. The old notes must be withdrawn as soon as possible for convenience' sake; but it is not imperatively necessary, because the value of the old pounds can always be paid in decimal coin, every £ being worth M. 960. This alteration will cause neither loss nor gain to anybody, and therefore cannot be very objectionable. Let all your readers, however, be assured, that any trifling inconvenience they may at first experience, will be speedily remedied by the beautiful and regular working of the decimal system, and that they will soon be repaid at a heavy rate of interest.

Allow me to correct a misprint at page 68 of your June No., because it is of some consequence. The heading of the column in the addition sum, should be £ s.d. f. and not £s. d.f. as printed. The reason of this is, that all figures on the left of the decimal point stand for *libras;* while those in the first, second, and third columns on the right of the decimal point, respectively, represent *sols*, *dents*, and *farthings*. In book-keeping, a line may be used instead of the decimal point, thus £.|s.d. f., 1|0 0 0 or, as I recommend, three columns may be used as now, only the middle or shillings column need only be wide enough for one figure, since one figure will always express the *sols*, thus, £.|s.|d.f. 1|0|0 0, from which it will appear, that business-books will do ruled as they are at the present time.

JACIA.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

PRESIDENT'S CONVERSAZIONE, JUNE 27.

[Conclusion of the paper "On Harbours of Refuge," by the Right Hon. the Earl of Lovelace.]

Mr. Alan Stevenson's clever experiments on the force of waves striking opposing bodies were given, and it was urged, that the force shown to be developed by a breaking wave could not act upon a vertical wall, up and down which it would merely oscillate, whereas it might fall with all its accumulated force upon a slope, upon which it would naturally break.

In conclusion, it was urged, that although for Dover, which was the spot whereon to mount guard over the Channel, in order not only to prevent invasion, but to maintain our present naval supremacy, it might be permitted to expend a large sum of money, yet it would not do *to have several Dovers;* and therefore it behoved the authorities to consider carefully the site, the plan, and the method of construction, before commencing works in which, in the present state of engineering science, the experience of the past should be used to avoid the errors that had occurred in former and similar works.

In the discussion which ensued, and in which the principal civil engineers engaged on great hydraulic works took part, after justly complimenting the Earl of Lovelace for the very able and impartial analysis he had made of the evidence contained in the Government Reports, and the documents in his possession, the speakers explained most satisfactorily the actual circumstances and conditions of the works which had been instanced as failures; and it was shown, that far from being expensive or useless works, they had been completed within the original estimates, and that wherever the construction had required restoration or additions, it had arisen from the use of defective materials, which, being on the spot, it had been obligatory to employ, and not from the use of the long slope, which, as compared to vertical walls in similar situations, was shown to be more durable, and to have been in many instances successfully substituted for vertical walls, after the latter had succumbed to the assaults of the raging billows.

INSTITUTION OF MECHANICAL ENGINEERS—SPECIAL GENERAL MEETING, BIRMINGHAM, JUNE 13.

J. E. M'CONNELL, ESQ. VICE-PRESIDENT, IN THE CHAIR.

Owing to the absence of Mr. Stephenson, his promised paper "On the Fallacies of the Rotatory Engine" was deferred, the following being substituted for it, "On the Balancing of Wheels," by J. E. M'Connell, Esq.:—

The advantages derivable from balancing the wheels of locomotive engines and railway carriages and wagons are very important; and the object of this paper is to bring the subject more prominently before the members of the Institution of Mechanical Engineers, in order that the value of balancing railway wheels, and also all other machinery, may be properly understood. There is a class of accidents which, from their frequent recurrence and the evil consequences resulting therefrom, require the careful attention of engineers connected with railway business: I mean those accidents where, from a rapid rate of travelling, the oscillation progressively increases in violence, and in a jumping or jerking motion, the engine or carriages jump from the rails; and I hope to demonstrate, that the origin of these frightful cases, causing loss of life and immense damage to the property of the railway companies, is simply the absence of a proper equilibrium in the movement of the wheels and machinery of the engines and carriages; and although there may have been, in one or two instances, a fault in the rails or condition of the permanent way, even that was produced by the irregular working of the same machine on previous occasions.

Before proceeding to explain the results of many experiments and the rules which they afford, I wish to mention that the merit of instituting the first systematic inquiry into effects of balancing wheels, is due to Mr. George Heaton, of Shadwell Street Mills, Birmingham, who, since his attention was drawn to the subject in the year 1810, has laboured earnestly to effect a proper plan of balancing wheels in all kinds of machinery. Here it may not be out of place to read a description of the origin of his investigations, as detailed by Dr. Melsom, when delivering a lecture on Physical Mechanics, at the Birmingham Philosophical Institution, in the year 1842; possibly in the room in which we are now assembled:

"It was in the year 1810, whilst Mr. Heaton was employed at Combe Abbey, by the late Earl of Craven, in a part of his lordship's establishment, kept for the amusement of himself and his visitors in the practice of mechanical pursuits, as turning, sawing by circular saws, ornamenting by the aid of rose engines, &c., the

covers of snuff-boxes and other fancy articles, that. finding his hand-power insufficient, his lordship determined to have a small steam-engine erected of sufficient power to drive the lathe, &c. at the requisite speed. The engine having been put up, his lordship and many of his visitors were surprised to find, that when one of the lathes was urged to a speed of about 600 revolutions in the minute, it began to shake, and shook to such an extent as the speed was augmented, as to raise the whole lathe and frame from the floor upon which it was placed. Mr. Heaton was, of course, consulted as to the cause of this agitation, and he attributed it unhesitatingly to the fact, that the revolving parts of the machine, the pulleys, were not equal in weight on both sides of the centre. The lathe was of beautiful workmanship, made by one of the best makers in London, and the pulley suspected of the fault was made of rosewood, on which was fixed a dividing-plate. Now, it was probable that the texture of the wood being closer on one side than on the other when *dry*, was the cause of this inequality in the weight. Mr. Heaton had immediate instructions to remedy this defect if possible, and he accomplished it in the following manner:—He bored a hole on the light side of the pulley 3½ inches from the centre, and introduced into it nine ounces of lead, which was the quantity required to make the pulley perfectly in balance. The lathe was now again set to work; and at a speed of 600 revolutions per minute, or any other speed requisite for its work, it was perfectly free from shaking. This rocking motion was now illustrated on a large model, whose axis was of the breadth of the ordinary railway gauge, and its two revolving rods of the length of the diameter of the wheels of a locomotive engine. Being unequally balanced, and made to revolve by a weight of six pounds, it exemplified the rocking motion of the lathe. The same motion, Dr. M. observed, may also be noticed in some of the guide pulleys that are heavy-sided on the railways, where a rope is used to draw the train along, particularly when the train runs fast. Here several corrections of machinery, both of lighter and more ponderous construction, were severally detailed, in which Mr. Heaton had succeeded, by attention to this principle, in producing an equable motion, where before the most violent and unaccountable agitation had prevailed. One striking instance occurred in the latter part of last year: An application was made to the firm of Heaton Brothers, Shadwell Street, for instructions to remedy the evil attendant upon the working of a fan used for the purpose of creating a blast for melting iron; this fan had been set to work, but the steam-engine by which it was driven was found incapable of getting it up to the required speed, which was about 1000 revolutions per minute, and when it approached that speed it shook the whole of the buildings, and shook itself loose from its bearings. To obviate this position of affairs, the proprietors removed it into another position, and propped it with strong timbers, which strong timbers had their bearing under a heavy wall. When again set to work, it shook the whole place as before, and made so much noise that the proprietors were threatened with a prosecution for nuisance. At this critical juncture of affairs, Messrs. Heaton, having been consulted, immediately took the fan to pieces, and found it 2lbs. 8oz. out of balance. The evil was rectified, and the fan restored to its former position, short of the whole of its props, &c. The engine was now set to work, and was found capable of driving the fan the requisite number of times; the nuisance was removed, and the fan had never since displayed any disposition to move from the place where it was set. Here an important observation was made, to the effect that the outside of the wings of this fan, which was three feet in diameter, when running at 1000 turns per minute, does not travel quite twice as fast as the rim of the wheels of a railway train, when the train is running at the speed of thirty miles an hour. The motion of the fan was now imitated on the large model, in which experiment the weights on the outside of the steel rods were not propelled at the rate of fifteen miles an hour, although the effect was so violent; whilst, at the same time, the weights travelled at a uniform speed in each part of their revolution. This was not the case with the wheels of a railway train; for if a train were travelling at the rate of thirty miles per hour, the top part of the wheels would, of course, have a much greater motion than the centre. If, then, such an effect were produced by the model, when only twelvé ounces out of balance, and only moving that twelve onnces at the rate of fifteen miles per hour, what effects were we not prepared to expect from a railway wheel thrown forward at four times the speed, and where, as in many instances was the case, the wheels were each four times that amount out of balance?"

I could also, if necessary, instance several recent accidents on railways, resulting, I believe, from the same cause, and also from a want of balance of another description, to which I mean to direct the notice of the members of this Institution at a future meeting. The more clearly to account for the great effects produced by balancing wheels, I have carefully noted the experiments made, in order to found some general principle by which they are to be regulated; and I find that the laws of central forces will afford the proper data. By the laws of central forces, when a body is made to revolve in a circle round some fixed point, it will have a continuous tendency to fly off in a straight line, at a tangent to the circle—which tendency is called the centrifugal force; and the opposing power by which the body is retained in the circular path is called the centripetal force; and both forces, when taken together, are termed central forces. Now, it must be self-evident, that the centrifugal forces of two bodies of unequal weight, moving with the same velocity, at the same relative distance from the central body, are to one another as the respective quantities of the two bodies. Further, the centrifugal forces of two equal bodies which perform their revolution round the central body in the same time, but at different distances from it, are to one another as the respective distances from the central body. The centrifugal forces of two bodies which perform their revolution in the same time, and whose quantities of matter are inversely as their distances from the centre, are equal to each other. The centrifugal forces of two unequal bodies moving at equal distances from the centre, with different velocities, are to one another in the compound ratio of their quantities of matter and the squares of their velocities. The centrifugal forces of two equal bodies moving at equal distances from the central body, but with different velocities, are to one another as the squares of their velocities. The centrifugal forces of two equal bodies moving with equal velocities at different distances from the centre, are inversely as their distances from the centre. The centrifugal forces of two unequal bodies moving with equal velocities at different distances from the centre, are to one another as their quantities of matter multiplied by their respective distances from the centre. The centrifugal forces of two unequal bodies moving with unequal velocities at different distances from the central body, are in the compound ratio of their quantities of matter, the squares of their velocities, and their distances from the centre.

Without entering on the wide subject of central forces, which would require more space and mathematical reasoning than this paper can embrace, I shall now illustrate, by a few examples on the models before the meeting, the effects of wheels unbalanced and in balance.

In order to arrive at a correct principle of balancing wheels, it is only necessary to find out by a delicate apparatus,—such as having the wheel suspended by the centres of a lathe, or other centres, so that there may be as little possible friction in revolution, and then by tying a weight at the periphery of the wheel to overcome the inertia,—the difference required at one point more than another, necessary to place the wheel in perfect balance. This test is only necessary at four points; having first discovered the heaviest side, the opposite or lightest, and then the other two at right angles to these, proceed to place balance weights as required.

With engine wheels on a crank axle, it is necessary to attach all the rods and other appendages which increase the weight of the wheel in revolving, and consequently great care is necessary to place these parts in their natural position, as when at work.

It is a fact worthy of notice, that two wheels cannot be balanced on the axle at the same time. One wheel requires to be put on and fairly balanced by itself; and when properly adjusted, the other is added; and precisely the same process must be again performed. In connexion with this subject, I have observed a singular effect produced by a want of balance, which may be very interesting. In the year 1846, a number of powerful merchandise engines were delivered, by various makers, to the London and North Western Railway Company; and so far as the plan and construction of the engines were concerned, the company was satisfied; but in a short time a flat place was found on the tyre of the wheels, exactly opposite to the crank. Many reasons were assigned for this, but none were correct; and the matter was submitted as a fatal objection to the engines. I was consulted on the subject, and at once gave it as my opinion that the sole cause was a want of balance. An engine was put in balance; and the cause being removed, the engines were again restored to favour. The saving in power by the wheels being put in balance is very considerable; and I know from experience, that were this subject taken up with a desire to put all wheels in balance as perfect as possible, 10 per cent. of traction force would be saved. I have now to introduce to the meeting a small model, showing the advantages of another kind of balance, which, in its results, will, I believe, do as much for the prevention of accidents than even the balancing of wheels—I mean the balance to the momentum of piston and rod. As it will, however, form the subject of a future paper, I shall merely submit the model to the members; and I trust they will give the matter their earnest consideration.

TABLE OF EXPERIMENTS with the small model No. 2, composed of an upright spindle, having a piece of brass wire put through the top part of it, in such a manner as to allow of its being moved, and set longer at one end and shorter at the other, &c.

EXPERIMENTS.	Weight to give Motion.	Time in Motion	No of Revolutions
1. A piece of brass wire, 12 in. long, weighing 4 oz., and set in the spindle with the ends at equal lengths from the centre. The weight to give motion falling in each Experiment 2 feet 4 inches.....	lbs.	Seconds.	
	1½	45	165
	3	46	206
	6	46	241
2. The wire set all out on one side of the spindle, and consequently out of balance.....	1½	32	56
	3	33	56
	6	30	57
3. The wire set 4 inches long at one end, and 8 inches long at the other.....	1½	32	72
	3	30	78
	6	29	85
4. The wire with a 6 oz. weight upon one end, and fixed in the spindle in such a manner as to make each end of an equal weight.....	1½	56	143
	3	56	173
	6	59	206
5. The 6 oz. weight removed, the wire remaining in the same position as in the last Experimcut, No. 4.	1½	36	67
	3	33	70
	6	29	69

Model No. 4 was made more nearly to resemble the railway carriage wheels and axle. It consists of a round axle fixed to run in two brass chairs, resting upon a small wood frame, with an eight-day clock spring and barrel upon the frame, to give motion to the axle, and by that means to keep its power within itself. There are two flanched wheels, one on each side of the axle, 6¼ in. in diameter, bearing about the same proportion as a railway carriage wheel; by placing some loose pieces of iron inside of the wheels, so as to make them represent wheels that are ½ in. thicker on one side of the periphery than the other, and the thick sides on the opposite side of the centre (a position which it is the practice of wheel-makers to place them in, and which, according to the models, is the very worst), if the string from the spring barrel is wrapped round the axle and let go, the model will begin to jump

about the table; or if held in a person's hand, it will soon get the whole into a shake, so as to beat time with it in a similar manner to many of the railway carriages.

In the course of the reading of the paper, Mr. M'Connell exhibited numerous experiments explanatory of the subject. The first showed the wheels of a model machine in balance, motion to which was communicated by a spring; and the regularity of the motion of the wheels was strikingly evinced. Afterwards, a small piece of iron was inserted between the arms of each wheel at opposite joints, which entirely destroyed the balance, and gave rise to considerable jerking, or unsteadiness. Similar experiments were made to show the advantage of also balancing the piston-rod, which, more than anything else, Mr. M'Connell believed, would obviate the unpleasant, and sometimes dangerous, jolting of railway trains.

With respect to the mode of balancing wheels, Mr. M'Connell stated that two wheels could not be properly balanced together: first one is balanced, and then the other on the opposite side. When this subject was first brought under the notice of Mr. Robert Stephenson, it was not considered to have any value, and it had many opponents; but more recently Mr. Stephenson's attention, and that of other eminent engineers, had been called to it, and their opinion was now favourable. These parties, however, adopted another method, which he, Mr. M'Connell, did not consider to be the correct one; namely, that when a locomotive is to be connected, and the driving wheels and working parts to be attached, it is lifted upon centres, and the wheels set slowly in motion—balance weights being added until they move at a particular speed without rocking, and become perfectly setted on their centres. That plan might answer tolerably well, but he did not consider it to be the really true method of balancing wheels. On a future occasion he would, probably, bring before the Institution the subject of balancing the piston and rod, and connecting rod, to which he attached very great importance. He believed the want of this balance to have caused many such accidents as engines leaving the rails, even when the wheels were in balance; for when an engine attains a high velocity—say, when the piston-rod travels at the rate of 1000 feet per minute, the momentum of the piston becomes so great, that the engine must jump and oscillate, causing the front wheels frequently to clear the road. This effect he had succeeded in completely neutralizing, in experimenting at Wolverton with an engine perfectly balanced. It was six years since Mr. Heaton introduced the subject to him (Mr. M'Connell), and he then adopted it on the Birmingham and Gloucester Railway. He believed that to have been among the first instances of its having been brought into practice.

Mr. Middleton said, he knew that considerable prejudice had at one time existed against the system of balancing, so ably brought forward by Mr. M'Connell. He had been associated with the author of the system, Mr. George Heaton, in having tried it on the London and Birmingham and other railways, but they met with great discouragement. He was, however, still convinced that it was one of the best means of securing the utmost safety in railway travelling. It was first introduced in 1839, on the London and Birmingham line; and he had also then been in communication with Messrs. Sharp, Roberts, and Co. of Manchester, on the subject; but it was, as Mr. M'Connell had stated, first adopted in practice on the Birmingham and Gloucester line.

Mr. M'Connell observed, that Messrs. Sharp, Roberts, and Co. did not take the true plan. Instead of balancing each wheel and each crank by itself, they put a balance weight opposite to the two cranks; and that system they carried on for a considerable time.

Mr. Cowper said that Messrs. Braithwaite and Milner had balanced wheels on the Eastern Counties lines eleven years ago; and after coming to Birmingham he had heard of Mr. Heaton's plan, which he found to be precisely the same as that on the Eastern Counties. This, however, was a decided improvement on any he had seen before.

ON AN EXPRESS LOCOMOTIVE ENGINE.

By J. Samuel, Esq.

The small locomotive lately introduced on the Eastern Counties Railway having attracted considerable attention, has induced me to present to your notice a short description of it; and, at the same time, to offer a few observations on the applicability of the principle to the conveyance of passengers on branch lines of railway. This "carriage engine" was constructed, under my superintendence, for the purpose of conveying the inspectors and myself on the Eastern Counties Railway, and thereby avoiding the great expense of special engines. The total length of the carriage is 12 feet 6 inches, including machinery, water tank, and seats for seven passengers—all on one frame, which is hung below the axles, and is carried on four wheels, 3 feet 4 inches in diameter. The floor is within 9 inches of the level of the rails. It is propelled by two cylinders, 3½ inches in diameter, with a 6-inch stroke, placed on each side of the boiler, and acting on a crank axle. The boiler is cylindrical, placed vertically; and is 1 foot 7 inches in diameter, by 4 feet 3 inches in height. It contains a fire-box, 16 inches in diameter, by 14 inches in height; with 35 tubes, 3 feet 3 inches long, by 1½ inches in diameter; giving 5½ feet of heating surface on the fire-box, and 38 feet on the tubes. The engine is fitted, complete, with link motion, feed pumps, &c. The water tank is placed under the seats, and will contain 40 gallons. This carriage is capable of conveying seven persons, at a rate of 30 miles an hour; it has at times attained a speed of 44 miles. The consumption of coke is only 2½ lbs. per mile; and the weight of the whole machine does not exceed 25½ cwt., including coke and water.

The result of observations which I have for a considerable time been making on the Branch *Passenger* Traffic of Railways, has been to convince me that, on the whole, it is not remunerative; and, in some cases, it is even worked at a loss. I have, therefore, been led to consider, whether the expenses might not be reduced by the introduction of a system of steam carriages more suitable to the amount of traffic to be conveyed. It is evident that the more we can reduce the dead weight of the trains and engines, in proportion to the number of the passengers, the less will be the expense of repairs, both of the carrying stock and engines, and of the way and works of the line. The average weight of a train on the branch lines of the leading railways is 56 tons,—the number of passengers conveyed by each train not exceeding 35 to 40 on many of the branch railways in England. Supposing each passenger with luggage to weigh 1½ cwt., the total weight of the passengers conveyed is about 3 tons; or, in other words, for every ton of paying load now carried by the system of locomotion, we have 18 to 20 tons of dead weight.

It is, therefore, in a commercial point of view, of the greatest importance, not only to railway companies, but also to the public generally, that some less expensive, and, at the same time, equally safe means of transit be adopted. Accordingly, it is proposed to substitute for locomotives on branch railways, steam carriages similar in construction to the accompanying drawings. These drawings represent a patent steam carriage now in course of construction, under my direction, by Mr. W. B. Adams, the patentee; intended for the Eastern Counties Railway Company.

The following are a few of the principal dimensions:—Diameter of cylinders, 7 inches; length of stroke, 12 inches; diameter of driving wheels, 5 feet; distance between centres, 20 feet; width of framing, 8 feet 6 inches. The boiler is of the ordinary locomotive construction—5 feet long, by 2 feet 6 inches in diameter; the fire-box is 2 feet 10½ inches, by 2 feet 6 inches. There are to be 115 tubes 1½ inches in diameter, and 5 feet 3 inches in length; giving 210 feet of heating surface on the tubes. The area of the fire-box is 25 square feet; giving a total of 235 feet of heating surface on the boiler. The consumption of coke I have estimated at 7 lbs. per mile, at a velocity of 40 miles per hour. The total weight of the steam carriage, with coke and water, will not exceed 10 tons; and it will be capable of conveying about 42 passengers, at a speed of 40 miles per hour. The water will be carried below the floor of the carriage, in wrought-iron tubes 12 inches in diameter, and 12 feet long.

One great object attained in this machine is the lowering of the centre of gravity, from which there will be a consequent absence of lateral oscillation. It is intended for the Enfield and Edmonton branch of the Eastern Counties Railway, and is expected to be at work in about three months from this date. When its practical utility and economy have been proved, I shall be glad to submit the results to the Institution, as I feel convinced that the subject is one deserving the attention of the members, and of all parties interested in the profitable working of railways. I may add, that were the system of light steam carriages adopted, branch railways might be constructed at a very small cost indeed, compared with the present outlay—an outlay which is unavoidable with the system of heavy engines; and the advantages of railway accommodation might be extended to districts which can never hope to enjoy them so long as the present system, which requires so great an outlay of capital, is continued.

Mr. Samuel begged to state, that one of the chief recommendations of his engine was the very great saving it would effect in the wear and tear of rails arising from the difference in weight between it and the present class of engines. From experience, he estimated the wear and tear of rails at £80 per mile per annum; besides the wear in the tyres of the driving wheels, which all knew to be large. In constructing branch lines, and also where the traffic was light, he proposed to lay light rails, and to use only these little engines; and, by these means, the first cost of such lines, as well as the current expense, would be very materially lessened.

In answer to questions by Mr. Cowper, Mr. Samuel said that there would be no difficulty in providing for the conveyance of goods or passenger trains more than usually heavy; and, in answer to the Chairman, he said, that it would be desirable to lay the light rails he had spoken of on longitudinal timbers, so that heavy engines might, as occasion required, run over them with safety. A member inquired what amount of steam pressure the engine usually worked with,—to which Mr. Samuel replied, that the usual amount was 120 lbs.; but it was not his intention to work with more than 80 lbs. in future.

The Chairman and Mr. Cowper concurred in thinking, that for branch lines, where the traffic is not usually heavy, Mr. Samuel's engines might be used with considerable advantage and economy, and that, by some such means, these lines, generally so unproductive, might be made remunerative to the proprietors. The Chairman, however, thought an objection might be taken that the passengers would be subject to a delay at the junction with main lines. Mr. Samuel replied, that the delay would be amply compensated by the increased speed he expected to obtain. He might add, that he had made a calculation that the cost of conveyance of passengers by his arrangement would not exceed one-fifth of a penny per mile. All would admit, that the unprofitable working of most branch lines demanded that some means of economizing the expenses should be introduced.

The Chairman did not think it advisable to lay down lighter rails than those now in use. In conclusion, he begged to intimate that the engine in question was at the London and North Western Birmingham station, in steam, that the members might personally witness her working.

ON A BOILER AND CONDENSER SUITABLE FOR EXTENDING THE CORNISH ECONOMY, AND FOR PREVENTING BOILER EXPLOSIONS.

By T. Craddock, Esq.

At the last meeting of the Institution, several questions were put to me, some of which I was not at the moment prepared to answer. The question put by Mr. M'Connell relative to the economy of my boiler in the generation of steam, when compared with the common boiler, I am not even yet prepared to answer, as I have not been able to find time to make such experiments with the two boilers as would enable me to make a conclusive reply. Before referring to other questions raised at that meeting, I will offer a few observations on the advantages of two

cylinders when nsed for expanding steam from a very high to a very low pressure, as proposed by me. Mr. Crampton allnded to the loss shown by the curve of the indicator figure, and I am quite as sensible of this loss as Mr. Crampton or any one else can be,—as, long ago, I publicly assigned that as the reasou which had induced me to design and construct engines on the principles of the one now before this meeting, and whicb, on investigation, will, I tbink, be found calculated to effect the object desired. But I wisb to remind the meeting, that the indicator will not detect the loss allnded to as that arising from tbe steam being condensed by the comparatively cold metal of the cylinder;—tbe water resulting from sucb condensed steam being in contact witb the heated metal, aud baving free communication with the condenser, reabsorbs the heat; tbus rendering that heat and water inert when we require it active, and active when we require it condensed. I think, bowever, that tbe validity of Mr. Crampton's assertion is open to question. He asserts tbat the fly-wheel will meet tbe objections without the two-cylinder engine. If the irregularities, and other difficulties attending the one-cylinder system, are not considerable. the fly-wbeel will meet the difficulty; but the matter is very different wben, as in my case, we avail ourselves of the expausive principle to the fullest extent; and to render that safe and practicable, was tbe primary motive which led to these arrangements. To illustrate the matter, let us suppose it desirable to use steam, at the commencemeut of the stroke, at 200 lbs. per square inch; that steam being reduced by expausion, before it quits the cylinder, to 3 lbs. per square inch (wbich would require the steam to be cut off at about 1-64th of the stroke; to do which in one cylinder, it must be of large capacity); hence we have 200 lbs. on tbe square ineb acting upon an extensive piston area at the commencement of tbe stroke, and at its termination only 3 lbs. It must be very obvious, that this would prodnce immense strain upon all tbe working parts of the engine; to meet whicb they would require to be inconveniently heavy and strong; besides, what weight of fly-wheel wonld be required to equalize such a motion? Yet, witb an engine on similar principles to the one before the meeting, all the difficulties are met by a reduction of weigbt and bulk of engine. The strain, also, upon the various working parts is kept quite as low as in the low pressure engine. I think, if gentlemen will bear in mind these reasons, and others which will readily suggest tbemselves, they will agree with me that there are strong and valid grounds for concluding that the double-cylinder engine does possess advantages for carrying ont the expansive principle as I propose it—advantages which are supported by the soundest theory, and are confirmed by practice.

In replying to other questions, I sball endeavour to be brief. In large boilers, snch as those exbibited in tbe drawings before the meeting, for marine and locomotive purposes, the extent of surface on which the heat generated in the furnace acts, is 30 square feet for every 62 lbs. of steam required to be generated per hour; three-fourtbs of such surface being exposed to the radiant heat, and one-fourth to the communicative heat. The extent of surface required in the condenser to condense 62 lbs. of steam per hour, is 70 square feet when air is the medium of condensation. With water as the medium of condensation, 16 square feet of surface is sufficient for the condensation of 62 lbs. of steam per bour. With air as the medium of condensation, 62 lbs. of steam, generated under a pressure of 100 lbs., will, with such engines, produce at least 3 horse power. And with water as the medium of condensation, 4 horse power is easily obtainable from 62 lbs. of steam per hour.

From this it follows, that the surface necessary in the condenser, per borse power, is one-third of 70 square feet, or $23\frac{1}{3}$ feet,—whereas, with water as the medium of condensation, the surface required in the condenser will be one-fourth of 16, or 4 square feet per horse power. In reference to weight of boiler, condenser, and engine, I am prepared to state, that the boiler with casing, grate, steam-chest, and all complete, does not exceed I cwt. per borse power. The condenser, when air is tbe medium of condensation, does not exceed $\frac{3}{4}$ cwt. per horse power; and with water as the medium of condensation, the condenser would not exceed 40lbs. per horse power. Tbe coal required, with air as the medium of condensation, is 3 lbs. per horse power per hour; and with water as the medium of condensation, it would be even less than 3 lbs. Again: we find the weight of boiler, condenser, and engine, even with air as the medium of condensation, not to exceed $2\frac{3}{4}$ cwt. per horse power. If we contrast this weight with that of the "Banshee" engines, lately tried in a Government vessel, and wbich is a fair weight of the present make of engines, we find the "Banshee" engine and boilers (with water) weigh 280 tons for 350 horse power.

The weight of an engine, boiler, and condenser, on the principle of the one before the meeting, equal to 350 horse power, would not exceed 60 tons; which is not one-fourth of those of the "Banshee,"—whilst I know that the consumption of fuel would be reduced nearer two-thirds than one-half of that necessary in the instance given.

Much was said at the last meeting about a comparison in actual work. Since then I have been informed by Mr. Humphries of Pershore, that with one of these engines, made for him by me, and which is far from being so perfect as experience would now enable me to make it, be thrashed 50 bags of "gardy" cut wheat with 3 cwt. of coals,—whilst a neighbour of his, with another engine, thrashed 30 bags of wheat with 30 cwt. of the same quality of coal.

Mr. Craddock added, that these boilers would, if necessary, generate steam at 200 lbs. pressure; and yet no such accident as that which had recently occurred at Dudley could take place.—In answer to a member, he stated that he had been in communication with the Admiralty, who said they could not adopt his suggestion. He did not know what their opinion was, but his were not suggestions, they were facts; and he had an engine of nearly 100 horse power constructed on this principle.—Mr. Henry Smith wished to know the comparative power of working the refrigerator and the common pump.—Mr. Craddock replied, that a condenser equal to 40 horse power would not take one horse power to drive it. It had been objected that the joints of the refrigerator were not tight; but he would engage to construct them perfectly so.—Mr. M'Connell inquired how the water in the boiler was kept at a regular height?—Mr. Craddock replied, that there were taps for the purpose.—Mr. M'Connell said he had previously asked the question of the relative economy of this engine, and the one somewhat similar to it in power at the London Works, and he did expect that either Mr. Craddock or Mr. Cowper would ere this have given the Institution some data to found upon.

Mr. Craddock said he had stated the relative economy to be 50 per cent., and it rested with Mr. Henderson, and not with him, to explain why the trial had not been made. He (Mr. Craddock) had always been anxious for it.—Mr. M'Connell could not doubt the statement of Mr. Craddock, and he was anxious to give the engine every proper advantage; but when that gentleman talked of saving 50 per cent., it became an important matter to have some data by which to arrive at an opinion; and he thought the Institution should not be committed to anything which had not been accurately and sufficiently tested by experiment.—Mr. Cowper said 50 per cent. might seem rather large; but they knew that the Cornish engine effected a saving of nearly 60 per cent. over the old engines.

Mr. M'Connell said, his only wish was to prevent the Institution committing itself to an opinion, without having the merits of the engine fairly tested; but he would be quite willing to admit its superiority, whenever he had the proper data upon which to decide. The question of the relative advantages of the double and single cylinders was not yet settled, and one of the members had been requested at the last meeting to prepare a paper on the subject. He thought, therefore, that experiments should be made, in order to determine the relative economy of the two engines. It had been suggested to him, as the chairman of the meeting, that a committee of members might be appointed to make the necessary experiments, with Mr. Craddock. If that would be satisfactory to Mr. Craddock, be believed that it would be satisfactory to the members of the Institution.

ON THE RECENT BOILER EXPLOSION AT DUDLEY.

By W. Smith, Esq., Dudley.

Having collected numerous particulars connected with the lamentable explosion of a steam boiler at the works of Mr. Jeffries, Hart's Hill, near Dudley, which occurred on the morning of Friday, the 2nd instant, I have great pleasure in laying them before the Institution; and for the better elucidation of my statements, I have prepared a drawing of the section of the boiler, and of a puddling furnace, one of four, the heat from which acted upon the boiler.

The boiler here alluded to is, in this district, termed "an egg-shaped furnace boiler,"—from being heated by puddling furnaces. The sectional sketch which I now produce will show the form, and also the distance and position in which it stood to tbe furnaces,—one of which acted upon each quarter of it, at right angles; the flame from the neck of the furnaces coming first in contact with the lower part of the outside shell, and then ascending to the cross flues, passed through them, and descended through the vertical flue to the chimney.

I shall now state the dimensions of the principal parts, together with the calculations of heating surface, steam space, &c.:—The boiler being, as before stated, egg-shaped, or rather a plain cylindrical one with hemispherical ends, there were four cross flues, and one main flue in the centre was placed in a vertical position, as shown in the drawing; its extreme height was 19 feet, and 9 feet 3 inches in diameter; the diameter of the four cross flues was 1 foot 10 inches; connecting the shell to the top part of the main flue, which was 5 feet in diameter at top, and 3 feet 9 inches at the bottom; the height from the bottom of the boiler being 14 feet.

The heating surface would therefore be—

Outside shell	160	square feet.
Four cross flues	50	ditto.
Main flue	196	ditto.
Total square feet	406	

Allowing 12 inches of water above the main flue, would give 668 cubic feet contained in the boiler. The remaining space for steam would be only 169 cubic feet. In order to form an opinion as to the quantity of water evaporated per hour, the quantity of coal consumed in the furnaces must first be ascertained; it was as follows:—Each furnace puddled between 22 and 23 cwt. of iron in 12 hours, and consumed between 28 and 30 cwt. of coal in six charges; and the operation is performed by first raising the furnaces to a white heat, until the charge of iron is melted,—which takes about half an hour; after which, the damper is shut nearly close until the puddling process is finished, which takes about forty minutes; and the blooms are drawn out and the furnace reheated for another charge. We have, then, 29 cwt. of coal consumed by each furnace in 12 hours, and $\frac{29 \times 112 \times 4}{12} = 1083$ lbs. per hour; and supposing, under the circumstances, that 20 lbs. of coal would evaporate one cubic foot of water, we have 54 cubic feet per hour; which I think is nearly correct. The result, then, for comparison is—

Heating surface	406	square feet.
Steam space	169	cubic feet.
Water space	668	ditto.
Water evaporated per hour	54	ditto.
Coals consumed per hour	1083	lbs.
Coals for one cubic foot of water	20	lbs.
Diameter of steam pipe to engine	$5\frac{1}{2}$	inches.
Diameter of safety valve (one)	4	ditto.
Diameter of feed pipe	$2\frac{1}{4}$	ditto.
Thickness of all the plates of boiler	$\frac{7}{8}$	of an inch.
Pressure per square inch on the safety valve	45	lbs., supposed.

The above facts show, that the steam space in this boiler was much too small for the heating surface, and for the other proportions of the boiler; and having examined the boiler on the 28th of April, I was aware of that fact, and advised Mr. Jeffries to make an addition to the steam space, as shown in my drawing by red lines. This boiler worked in connection with another cylindrical boiler about 25 feet long, and 5 feet 6 inches in diameter; of the ordinary construction, and heated in the ordinary way. Both together supplied steam for a cylinder 20½ inches in diameter, and 6 feet 6 inches of stroke,—making 20 to 22 strokes per minute. About four o'clock on the morning of the accident, this latter boiler was shut off, from being found to be leaking, and the boiler which exploded was left to work the engine by itself: this it did for about 2¼ hours, and then exploded. It appeared in evidence, that the engine was doing very little work at the time of explosion, as it was driving only the gearing and a roll-turning lathe at which the proprietor himself was working; but all the four puddling furnaces were in full work, and a great quantity of steam must have been blowing off by the safety valve, and the engine acting on the very small steam space had, in all probability, caused the boiler to prime, and suddenly thrown out a large portion of the water. I examined the pieces of the boiler about four hours after the explosion. The boiler was torn up in all directions; and I am convinced, from the appearance of the plates, that it had been short of water, and that the top part of the main flue, and the cross flues, had been red hot. I am also of opinion that the main flue had either collapsed in the first instance, or otherwise the crown of it had been forced downwards, and the steam, or water, descending into the main flue to the chimney, had blown it up, as also the stack which stood at about six yards from the boiler. Other particulars will be seen in the evidence given at the inquest; but I am sorry to say that the real cause of the accident seems still to be a mystery, it not being possible to ascertain the exact amount of weight upon the safety valve at the time, from the great difference of statement made by the two engine-men, and the proprietor appearing to be perfectly ignorant of it himself.

The Chairman inquired if Mr. Smith could assign any cause for the explosion?—Mr. Smith was convinced that the water in the boiler had become too quickly heated; which, no doubt, was one of the principal causes.—Mr. Cowper inquired if there were any stays to the flues?—Mr. Smith said there were not, although the engine was working at 45 lbs. pressure. He was of opinion that the boiler was not at all adapted to work high pressure steam;—it was on too large a scale, and there are many such in the neighbourhood of Dudley, but used chiefly for condensing engines. As near as he could ascertain, the boiler in question had been working at about 45 lbs. to the inch, which is quite a general thing in the neighbourhood. In fact, many engines are being daily worked there in a highly dangerous manner, and he felt strongly, that, for the safety of the public, some general superintendence should be established. It was most unsafe to allow matters to continue as at present.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

THE TRIFORIUM.

At the closing meeting of the session of the Institute, which was numerously attended, Mr. Bellamy took the chair; Mr. Charles F. Reeks was elected an associate. A list of donations was then read, including a communication by Mr. Roberts on the subject of labourers' cottages adapted to agricultural districts, with specifications, &c., according to a design recommended by the Society for the Improvement of the Condition of the Labouring Classes, and to which the Chairman drew attention. There were also amongst the donations, particulars as to the great clock at Westminster, presented by Mr. Bellamy.

Mr. Eaton Hodgkinson was then introduced on his election as an honorary member of the Institute, when he was addressed by the Chairman, who said the Institute hailed with satisfaction the advent to their ranks of a gentleman whose investigations into the nature and the laws which regulate one of the most dangerous materials with which architects and engineers had to do, had paved the way to a better knowledge of that material, and especially entitled him to the thanks of their profession.

Several foreigners were introduced by Mr. Donaldson, among whom was Dr. Forchammer, professor in the University of Keill.

The monthly report of the committee on students was read, and prize books were awarded to Mr. Thomas Hill and Mr. Bright Smith, when the opportunity was taken to recommend the students to adopt a larger scale of drawings, to put in simple tints, and carefully project their shadows.

The Chairman stated that Earl de Grey had been quite unable, from the precarious state of Lady de Grey's health, to preside at this meeting, as was expected, and that the presentation of the medals and prizes would be postponed till the opening of the ensuing session.

A discourse was then delivered by Professor Willis, on the triforium of ancient churches, in which he displayed much research and ingenuity in unravelling the mystification into which successive alterations, and changing purposes and habits, and meanings of terms, have plunged this question. As for the term itself, there was something rather curious in its history. The only ancient work in which such a term could be found at all, was a history of Canterbury (by Gervase), in which it occurred in three places, and with a local meaning quite different from the sense in which it is now used. He verily believed that the modern term was a mere clumsy latinization of "thoroughfarium." In the Basilicas, the manifest triforium was an upper gallery, high and lofty, and so arranged that men with business to transact might have freedom to walk and talk without interruption. In front was a high parapet, for the sake of privacy; in fact, it was a practicable gallery for business transactions. The first ecclesiastical triforium was that of St. Sophia, at Constantinople. Privacy was here, too, more particularly preserved, as it was intended for women, the separation of whom from the men was thus provided for by the formation of an upper floor. In the Ravenna churches, the triforium was still a practicable gallery; and where flat roofs were used, it is evident there was a reason for the introduction of a triforium other than the mere desire to turn the space beneath a high roof to some account, or to get rid of the difficulty by converting it into a gallery without reason or purpose at all. The professor then, with the assistance of diagrams and models, referred to the peculiarities and alterations affecting the triforium in a multitude of churches, including, as to its origin, those in the east, a few in Italy, with the early basilican churches at Rome, Romanesque and Lombard buildings, with curious triforia. On the banks of the Rhine, he remarked, no ancient triforia were to be found, nor in the Romanesque churches of Germany. In its ritual use the sexes had changed places, but at length the triforium went to sleep with ancient usages, and was lost. The awkward way of getting rid of the triforium at York was pointed out by aid of models, &c., and also the curious changes at Ely. One great object in many alterations of the triforium was evidently to remove darkness; and thus the triforia, in many cases, became practicable galleries lighted from without. The way in which high roofs were converted into flat ones, with the outer wall raised, and ornamental windows, visible from the body of the church, introduced, was ingeniously illustrated by models made of card-paper, stuck into mortices sunk in a base plan, and capable of being transfigured in a moment like the changes in a harlequin's dress. The professor, ostensibly for behoof of the students, described the way in which they were prepared, mounted, taken to pieces, and stowed away into portfolios like any other mere flat drawings. In some of them all the three or four sides of the model consisted of but one piece, tinted, cut out, and folded into proper form when mounted. By these means the alterations from one form to another, in several edifices, were rapidly illustrated.

The Chairman said, that of all vexed questions, none had been involved in greater obscurity than the subject of the triforium, and none had given more scope to the imagination; but Professor Willis had entered practically into this question, and by a comparative analysis had shown them clearly that triforia were really lighted thoroughfares. His discourse had carried to his mind an entire conviction. As to the models, there was a simplicity as well as ingenuity in these models, that he especially recommended students, in connection with what had been already said, to carry out substantially.

Some discussion then ensued between Mr. Donaldson and Mr. Willis on the subject of the term "early English," which Mr. Donaldson declared he did not think sufficiently definite; while, on the contrary, Mr. Willis regarded it as of value, chiefly because it involved no definite hypothesis, but was a mere general term ranking with others, such as early German, early French, &c., each of which comprehended peculiarities.

Mr. Tite asked whether the period was known when that division of the sexes to which allusion had been made was most prevalent or most generally ceased, as it might shed some light on various particulars connected with the triforium, and the history of its changes or alterations?—In reply, Mr. Willis admitted that his knowledge on this particular point was rather imperfect. He feared it was impossible to form a continued history of the triforium, and its changes in the western churches. After the period when processions to chapels in the different stories, including the triforium, ceased, it had failed in use and died out. The time of the Reformation was hinted at as probably a critical period in the history of the triforium, the use of which, as the Chairman observed, then ceased, and buildings were no longer erected on the same type; but the separation of the sexes did not then at once cease.

The Chairman announced that the council were making an arrangement to furnish members with copies of the papers read before the Institute, and he hoped it would be matured before the opening of the new session. In announcing the close of the present session, and the opening of the new on 6th November, the Chairman exhorted his friends to make the most of their time in preparing something worthy of the attention of the Institute, for which, in the present locked-up state of the Continent, they would probably have more opportunity and leisure at home than usual.

ROYAL INSTITUTION, JUNE 16.

THE DUKE OF NORTHUMBERLAND, PRESIDENT, IN THE CHAIR.

Mr. Faraday "On the Conversion of Diamond into Coke."

In the course of last year, M. Jacquelain succeeded in converting diamond into a substance possessing the appearance, physical character, and electrical properties of coke by the following process:—Having attached a piece of hard gas retort carbon to the positive wire of Bunsen's battery of 100 elements, he placed on it a small piece of diamond. He then armed the negative wire with a cone of the same carbon, and, by dexterous manipulation, enveloped the diamond with electric flame. After a short interval, the diamond underwent a sort of ebullition, became disintegrated, softened, and was actual coke. (*Comptes Rendus*, June 14, 1847; *An. de Chimie*, tom. xx., p. 459.) On this experiment Professor Faraday made the following observations:—1. *As to the property possessed by certain substances to assume totally different forms without undergoing any chemical change.* Professor Faraday adverted to the case of sulphur, which becomes brittle when suddenly cooled from its first state of fusion, but is soft and pliable when similarly cooled from its second state of fusion.—2. *As to the source of heat employed.* Professor Faraday dwelt on the beauty and power of the voltaic arc as a furnace, showing by experiment that diamond could be burned into carbonic acid gas by means of a current of oxygen gas directed on it when highly heated, the Professor stated that neither this heat nor any short of that of the voltaic battery, except that of the solar lens, was sufficient to convert diamond into coke. The fusion of rock crystal by a current of oxygen sent through an ether flame was noticed; and it was shown

that this powerful heat was inferior in intensity to that of the battery.—3. *The condition of the diamond when thus converted into coke.* It becomes absolutely lighter. The spec. gr. of ordinary diamond is 3.368; when changed into coke its spec. gr. is 2.679. It loses its insulating power.—Professor Faraday here alluded to some experiments by M. Karsten (*Archives des Sciences*, 1847), proving that certain compound bodies were conductors or not according to their preparation. He stated that this was the only case analogous to carbon.—4. *As to the philosophy of the change of the diamond's structure.* Referring to M. Gassiot's demonstration, that the heat is greatest at the positive pole of the battery, Professor Faraday suggested the possibility, that the particles of diamond might, under the influence of the intense heat, tend to form vapour having a sensible and assisting expansive force, and that in their axial position, as regarded the enveloping discharge, they might assume a state having relation to a diamagnetic condition. He requested to be understood, however, as offering this idea merely as a philosophical conjecture. Finally, he referred to Graham's supposition, that the difference between diamond and coke might depend on their known difference of specific heat.

FRANKLIN INSTITUTE.

Mr. Williams submitted to the inspection of the members two foot-warmers, which present a singular phenomenon. They consist of boxes of polished zinc for the purpose of containing hot water, and are covered with cloth embossed in different colours, lined with calico. The pattern embossed upon the cloth has imprinted itself upon the zinc, the metal being tarnished under the black, and having remained bright under the other colours.—Mr. Cardeza exhibited a rifle constructed to load at the breech, and made from his drawings in 1846. The gun was familiar to some of the gentlemen present, having been used in that year, in experiments upon the explosive force of gun-cotton. His reason for exhibiting it was, that a patent for the same thing had recently been taken out by a resident of New-York.—Mr. Smith exhibited a solution of gun-cotton in ether, and explained the advantages which it has as a dressing for wounds. He stated that a careful microscopic examination of it showed no fibrous structure, and gave no traces of the polarization of light, as had been affirmed.—Dr. Rand presented to the meeting, a patient who had been operated on for a cyst on the right elbow; the wound having been dressed with the ethereal tincture of gun-cotton. It had succeeded admirably, and allowed such free action of the joint during the healing, that the individual had been able to pursue his trade, that of a weaver. Prof. W. R. Johnson stated that gutta percha dissolved in chloroform, and gave a very similar substance by evaporation, which in addition to the advantages possessed by the tincture of gun-cotton, was more elastic, and therefore permitted of still freer motion without injury to the dressing.—Mr. Plotts explained the theory of his method of rational arithmetic, by means of which children could be taught so as to understand and explain every step which they are obliged to take in solving any problem presented. Mr. Plotts exhibited specimens of his method and illustrated the facilites which it gives.—Mr. M. T. W. Chandler called the attention of the members to a very beautiful model of a weigh-lock, on the plan of Messrs. Ellicott and Abbot's platform scale, which is now under examination by the Committee on Science and the Arts. The crib on which the boat rests while being weighed, is sustained by rods which operate on a series of steelyards, arranged longitudinally on each side of the lock. From these the strain is transferred by means of a rocking shaft, to another steelyard, placed above the lock and transversely to it, on which the weighing is effected.—*Franklin Journal.*

LOCOMOTIVE ENGINES FOR COMMON ROADS.—SIR JAMES ANDERSON'S STEAM CARRIAGE.

Undaunted by the disastrous failures of Gurney, Macerone, Squires, Hancock, and others who have adventured to mount the common road locomotive hobby, Sir James Anderson yet remains in the field, and he has almost completed a carriage which he intends to commence running immediately, between Hyde Park Corner and Hounslow, through Kensington, Hammersmith, and Brentford. A prospectus of the undertaking which we have before us, harps upon the old string, of a boiler, which the ingenious inventor has at last succeeded in perfecting, so as to fulfil all the requisites of strength, compactness, and capability of production of steam. This desideratum has been so often promised, that the mention of it carries with it a smack of the philosopher's stone, and we are fain to stick to the wise saw of "seeing is believing."

The engine is a four-wheeled one, with a front swivel axle for guiding by a steersman who sits at the front. The driving power is derived from two inverted steam cylinders, set at a right angle to each other in the centre of the framing, and both apparently working one crank on a centre shaft which carries pulleys for the transmission of motion by gutta percha belts to the large driving wheels at the back. The boiler is a vertical one; it is placed at the extreme back of the carriage, overhanging the driving wheels. Provision is made for a change of speed by alteration of the driving pulleys, and what is something of greater novelty, no escape steam is seen.

To work 100 miles each way daily, it is assumed that five locomotives and three passenger carriages will be required, as unlike previous arrangements of the kind, the locomotive itself, carries only its coke, water, and attendants.

The requisite funds for carrying on the enterprise, are proposed to be raised in the way of loans of ten pounds each, such loans to be repaid by five equal annual instalments, with interest at the rate of fifteen per cent. per annum, after which a bonus of four per cent. per annum is to be paid to the original lenders for the 12½ years which the patent has to run.

If zealous endeavours deserve reward, Sir James ought to be a heavy prize holder; but in these days of railways, it might perhaps have been worth his while to reckon carefully upon the likely commercial results of his speculation. Railways have attained a secure footing in the country; nine monied people out of ten are shareholders in them. Then the rate of travelling, who, except in out-of-the-way localities where there is no choice, will take a common road conveyance, at ten or even fifteen miles an hour, when thirty, forty, fifty, or sixty can be got by railway. If Sir James is right, there is yet hope for the turnpikes; tollmen will be no longer hermits, and we may again see a rubicund wayside innkeeper. The iron horse will be in need of hostlers of a new generation —that of coke and water; but he of hay and oats will still be a supernumerary until the race dies out. But we are outrunning the subject, and must lay by our pen until our old common road acquaintance makes his appearance. Let him have fair play, and win if he can.

THE MECHANIC'S LIBRARY.

Algebra, Key to Bridges', 12mo. 3s. cloth. Atkinson.
Architecture, Nicholson's Principles of, 6th edition, 31s. 6d. Gwilt.
Arithmetic, Higher Parts of, 12mo. 3s. 6d. cloth. F. Calder.
Arithmetic, Young Ladies', new edition, 18mo. 2s. cloth. J. Grey.
Astronomical Ephemeris for 1849–50, 1s. W. J. Simmonite.

Collieries, Winning and Working of, 8vo. 14s. cloth. M. Dunn.

Ecclesiastical and Architectural Topography of England, part 1, 8vo. 2s. 6d.
Euclid, with coloured Diagrams, 4to. 21s. sewed. E. Byrne.

Geography, Atlas of Modern, new edition, 4to. 5s. cloth. Parley.
Geography, First Principles of, royal 12mo. 3s. cloth. J. Bryce.

Industry, Organization of, 2d edition, 8vo. 5s. boards. T. C. Banfield.

Philosophy, Exact, books i. and ii., royal 12mo. 6s. H. F. Hallé.

Railways and Agriculture, 24mo. 2s. 6d. cloth. S. Sydney.
Railway Engine and Carriage Wheels, Comparative Account of, 8vo. 6s. cl. H. B. Barlow.

Scientific Library—Lectures on Painting, post 8vo. 5s. cloth. H. G. Bohn.
Shipping, Laws of, 3d edition, 12mo. 7s. 6d. cloth. J. Lee.
Steam Engine Explosions, the Causes and Effects of, 8vo. stitched. J. Wilder.
Steam, Incitements to Studies of, 18mo. 2s. cloth, sewed. W. Templeton.

MONTHLY NOTES.

Method of Working Pumps at Sea by the Wind.—Necessity is still very prolific in inventions, for we find she has supplied a means of working ships' pumps without manual labour. The captain of an American ship, on a late passage from Manilla to Boston, being short of hands, set his ideas to work to find out a substitute for working the pumps. It struck him that the wind might be efficiently employed upon the work, and he rigged up a small wind-mill, with four sails, in the following manner:—He first raised two spars perpendicularly, and parallel with each other, lashing them to the barrel of the capstan. The length of these spars was about 14 feet, and across their top he fixed a horizontal spar, 5 feet long, let into the ends of the uprights, so as to form the axis of the mill. To one extremity of this axis he fastened two cross pieces carrying the sails, and on the opposite end he attached a wooden crank, connected by a rod to the pump's brake. As the whole structure was attached to the capstan, it was an easy matter to bring the sails to bear on any point from which the wind might come, by turning the whole round. The apparatus saved the sailors a great deal of unwelcome labour; and, considering that it was entirely constructed at sea, it was a most efficient machine. On touching at St. Helena, he had some considerable improvements made in it, by the introduction of smiths' work, where he had before been compelled to depend upon timber.

Preparation of Daguerreotype Plates by the Electrotype.—Mr. Kilburn, the eminent photographist of Regent-street, London, has introduced the electrotypic system of preparing silver plates for the daguerreotype, with the best success. The improved surface produced by the electrotype deposit, is best explained by a comparison with the usual plated covering. If a prepared plate is placed in the decomposing trough of a Smee's battery, so that only one-half of its surface is immersed, and then finished in the usual manner, the extreme purity of the electrotyped portion is immediately seen by its superior brilliancy. This will be appreciated when it is remembered, that it is the black burnish which forms the dark portions of the picture. When a plate thus prepared is made sensitive, and placed in the camera, the electrotyped surface produces a perfect figure in one-third of the time of the other.

Dover Refuge Harbour.—This great national work is now progressing with much spirit, and begins to show symptoms of what it will be. The first portion, 800 feet of massive sea-wall, has been contracted for by the Messrs. Lee of London; and the works are carried on under the superintendence of their active agent, Mr. Scott, whose experience in similar works fit him, in a peculiar manner, to conduct this extensive undertaking. The plan is, we believe, that of Mr. Walker, the eminent engineer; and the execution of the engineering department also devolves on him and his partner, Mr. Burgess. The works now extend 130 feet into the sea, and the curve to the eastward has been commenced. One diving bell was put into requisition on Monday last, in the process of levelling the rocks for the foundation, and another will be brought into use next week.

ENGLISH PATENTS.

Sealed from 16th June, 1848, to 18th July, 1848.

George Emmott, Oldham, Lancaster, civil engineer,—"Certain improvements in the manufacture of fuel, and in the construction and arrangement of furnaces, flues, boilers, ovens, and retorts, having for their object the economical application of caloric, the manufacture of gas for illumination, and the consumption of smoke and other gaseous products."—June 16th.

Deane Samuel Walker, London Bridge, merchant,—"Improvements in the manufacture of bands or straps for hats, caps, shoes, and stocks."—24th.

Henry Archer, Shaftesbury Crescent, Pimlico, Middlesex, gentleman,—"Improvements in matches and in the production of light, and in the apparatus to be used therewith."—24th.

William Hunt, Dodderhill, Worcester, chemist,—"Improvements in obtaining certain metals from certain compounds containing these metals, and in obtaining other products by the use of certain compounds containing metals."—24th.

Richard Clark, Strand, Westminster, lamp manufacturer,—"Certain improvements in gas-burners, and in candle-lamps and other lamps."—26th.

Frederick William Mowbray, Leicester, paper dealer,—"Improvements in the manufacture of looped fabrics."—27th.

John Macintosh, Glasgow, gentleman,—"Improvements in obtaining motive power."—28th.

Joseph Skerchley, Anstey, Leicestershire, gentleman,—"Improvements in bricks and in the manufacture of tobacco-pipes and other like articles."—30th.

Elizabeth Dakin, 1, St. Paul's Church-yard, London, widow,—"Improvements in cleaning and roasting coffee, in the apparatus and machinery to be used therein, and also in the apparatus for making infusions and decoctions of coffee."—July 3d.

Nathaniel Beardmore, 13, Great College Street, Westminster,—"Certain improvements in founding and constructing walls, piers, and break-waters, parts of which improvements are applicable to other structures."—3d.

John Martin, Killyleagh Mills, Down, Ireland, manufacturer,—"Improvements in preparing and dressing flax, tow, and other fibrous substances; and doubling, drawing, twisting, flax, tow, and other fibrous substances; and in the machinery to be used for such purposes."—6th.

Joseph Clinton Robertson, 166, Fleet Street, London, civil engineer,—"Improvements in the manufacture of gas."—(Communication.)—6th.

George Beattie, Edinburgh, builder,—"An improved air-spring and atmospheric resisting power."—6th.

William Edward Newton, Chancery-lane, Middlesex,—"Improvements in the construction of stoves, grates, furnaces, or fireplaces, for various useful purposes."—6th.

Enock Steel and William Britten, Lambeth, Surrey, manufacturers,—"Improvements in the manufacture of tobacco-pipes."—6th.

W. O. Palmer, Southacre, near Swaffham, Norfolk, farmer,—"Improvements in machinery for threshing and dressing corn."—10th.

A. Lorimer, Bell's-buildings, Salisbury-square, City, book-binder,—"Improvements in combining gutta percha and caoutchouc with other materials."—10th.

R. Roberts, Globe Works, Manchester, engineer,—"Certain improvements in and applicable to clocks and other time-keepers, in machinery or apparatus for winding clocks and hoisting weights, and for effecting telegraphic communications between distant clocks and places otherwise than by electro-magnetism."—11th.

L. Castelain, Poulton-square, Middlesex, chemist,—"Improvements in the manufacture of soap."—11th.

F. A. F. de Beauregard, Paris, engineer,—"Improvements in generating steam, and in the means of obtaining power from steam-engines."—11th.

M. Kirtley, Derby, engineer,—"Improvements in the manufacture of railway wheels."—11th.

J. Ross, Leicester, agent,—"Improvements in apparatus for dibbling and other agricultural purposes; part of which improvements are applicable to propelling vessels."—11th.

W. E. Staite, Lombard-street, City, gentleman,—"Improvements in the construction of galvanic batteries, in the formation of magnets, and in the application of electricity and magnetism for the purpose of lighting and signalising, as also a mode or modes of employing the said galvanic batteries, or some of them, for the purpose of obtaining chemical products; part of which improvements are a communication."—12th.

William Swain, Pembridge, Hereford, brickmaker,—"Certain improvements in kilns for burning bricks, tiles, and other earthern substances."—18th.

Jean Louis Lemanaude, 30, Passage Jouffroy, Paris, jeweller,—"A new process of applying or fixing letters of metal upon glass, marble, wood, and other substances."—18th.

Charles Purnell, Liverpool, clockmaker,—"Certain improved apparatus to be applied to timber-loaded and other vessels laden with materials, the specific gravity of which is lighter than water, preventing the necessity of abandoning them at sea, by ridding them of the superincumbent water, and enabling them thereby to carry sail."—18th.

William Edward Newton, Chancery-lane, Middlesex,—"Certain improvements in machinery for letter-press printing."—18th.

Joseph Stenson, Northampton, engineer,—"Improvements in steam engines and boilers; parts of which improvements are also applicable to other motive machinery."—18th.

Johan Arnold Steinkamp, Leicester-street, Leicester-square, Middlesex, gentleman,—"Improvements in the manufacture of sugar from the cane."—18th.

SCOTCH PATENTS.

Sealed from 16th June, 1848, to 19th July, 1848.

Alexander Parkes, Birmingham, Warwickshire, experimental chemist,—"Improvements in the manufacture of metals, and in coating iron and steel."—June 21st.

John Scoffern, Upper Holloway, M. B.,—"Improvements in the manufacture and re6ning of sugar."—21st.

P. A. Le C. De Fontainemorean, 4, South-street, Finsbury, English and Foreign Patent Office for Inventions,—"Improvements in the process and machinery for making, uniting, and preserving metallic and other tubes or pipes."—(Communication.)—21st.

Joseph Wheeler Rogers, Nottingham-street, Dublin, civil engineer,—"Certain improved methods and machinery for the preparation of peat as fuel, and in combination with certain substances as a compost, or manure."—26th.

Charles Low, Roseberry-place, Dalston, Middlesex, gentleman,—"Improvements in the manufacture of copper."—29th.

Frederick William Mowbray, Leicester, paper dealer,—"Improvements in machinery for the manufacture of looped fabrics."—29th.

George Beattie, Edinburgh, builder and wood merchant,—"An improved air spring and atmospheric resisting power."—29th.

Thomas Dalton, Coventry, silk dyer,—"Improvements in the manufacture of fringes, gimps, and buillons."—29th.

Matthew Townsend, Leicester, frame-work knitter,—"Improvements in the manufacture of looped or knitted fabrics."—29th.

Richard Wrighton, Lower Brook-street, Grosvenor-square, Middlesex, gentleman,—"Improvements in apparatus to be applied to railway carriages and engines."—3d July.

Richard Clarke Burleigh, Featherstone Buildings, Middlesex, gentleman,—"Improvements in burners for obtaining or producing light and heat, and in apparatus to be used therewith."—6th.

John Martin, Killyleagh Mills, Down, Ireland, manufacturer,—"Improvements in preparing and dressing flax, tow, and other fibrous substances; and in doubling, drawing, and twisting flax, tow, and other fibrous substances, and in the machinery to be used for such purposes."—14th.

Sidney Edwards Morse, Ampton-place, Gray's Inn-road,—"Improvements in the manufacture of plates or surfaces for printing or embossing."—10th.

Robert Heath, Heathfield, near Manchester, Lancashire, gentleman,—"Certain improvements in the method of applying and working friction brakes to engines and carriages to be used upon railways."—18th.

Alexander M'Dougall, Longsight, Lancashire, chemist,—"Improvements in the manufacture of glue, and in treating products obtained in the manufacture of glue."—18th.

Jonathan Amory, Alhemarle-street, Middlesex, gentleman,—"A certain new and useful improvement in steam-boiler furnaces."—(A communication from Henry F. Baker, Massachusetts, United States, America.)—19th.

IRISH PATENTS.

Sealed from 20th June, 1848, to 20th July, 1848.

Robert Wilson, Greenock, Master of Arts,—"Improvements in certain kinds of rotatory engines worked by steam or other elastic fluids, part of which improvements are applicable to rotatory engines worked by water or by wind; also an improvement in safety valves for steam boilers."—22d June.

William Beckett Johnson, Liverpool, Lancashire, engineer,—"Certain improvements which are applicable to locomotive, stationary, and marine steam engines."—6th July.

David Williams Wire, 9, St. Swithin's-lane, London, gentleman,—"An improved manufacture of candles and other like articles used for affording light."—(Communication.)—10th July.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 15th June, 1848, to 19th July, 1848.

June 15th,	No. 1475.	Hugh Robertson, jun. Gartloch, Glasgow,—"Equilibrium lamp."
16th,	1476.	M'Conochie & Claud, Liverpool, engineers,—"Steering apparatus."
19th,	1477.	Francis Whishaw and Co. 6, Gray's-inn Square, London,—"Velocentimeter and uniformity of time regulator."
22d,	1478.	Thomas Jopling, Bishop Wearmouth, Durham,—"Maugle."
23d,	1479.	John Paterson, Cheapside,—"Waist belt."
—	1480.	Woods and Thomas, Cheapside,—"Rotary postage stamp and gum ticket damper."
28th,	1481.	Frederick Harris, Wood-street,—"Ticket pin."
29th,	1482.	Henry Dunington, Nottingham,—"Hat-hand."
30th,	1483.	Francis Willetts Bassano, Birmingham,—"Roof-lamp."
July 1st,	1484.	Robert and Francis Grassby, Marton, Hull,—"Thrashing machine."
—	1485.	Davidson and Armstroug, Manchester,—"Spindle-valve for pumps."
—	1486.	Arthur Hill Holme, Liverpool,—"Improved safety-valve box for steam boilers."
—	1487.	William Hill, Greenwich,—"Flue boiler."
4th,	1488.	Henry John Fry and William Downs Phipps, Sloane-street, Chelsea,—"Elastic spring boot."
—	1489.	Charles Marben, Warren-street, Fitzroy-square,—"Saddle."
—	1490.	Woods and Thomas, Cheapside,—"Secure hook and flexible dress fastener."
5th,	1491.	Charles Greenway, Park-street, Grosvenor-square,—"Stock."
7th,	1492.	R. Restell, Croydon,—"Cylindrical brooch protector."
10th,	1493.	G. F. Morrell, Fleet-street,—"Flower and plant label."
11th,	1494.	J. Sparks, King-street, Tower-hill,—"Railway dispatch and casb box."
12th,	1495.	William N. Nicholson, Newark-on-Trent,—"Newark cottage range."
—	1496.	William Bullock Tibbits, Brauston,—"Spring holdfast for window sashes."
—	1497.	W. R. Sobey, Exeter,—"Spring lock for a brooch."
—	1498.	G. Dickson, New Bond-street,—"Artist's vade-mecum."
13th,	1499.	John E. Smith & Co., Lawrence-lane, London,—"Shirt collar."
—	1500.	Charles Warren, Birmingham,—"Fastener for brooch."
14th,	1501.	Richard Clark and Thomas Restell, West Strand, and York-terrace, Camberwell,—"Press and cullender for vegetables."
—	1502.	Fountain John Hartley, Pump-row, Old-street-road,—"Fastener for umbrellas and parasols."
—	1503.	Foster, Porter, & Co., Wood-street, Cheapside,—"Victorine."
15th,	1504.	Thomas Heming, Maidstone,—"Shooting-coat and waistcoat combined."
—	1505.	Barnett Meyers, Crutched Friars,—"Mitred handle for walking-sticks, umbrellas, canes," &c.
17th,	1506.	George Josiah Maclean, Lochlade,—"Thrashing machine."
—	1507.	White and Wells, Nottingham,—"Under shirt."
18th,	1508.	Thomas Edwards, Birmingham,—"Solid leather cigar case."
19th,	1509.	George Unite, Birmingham,—"Slide bolt to secure the pins of brooches."
—	1510.	Weiss and Son, Strand,—"Forceps and scissors' joint."

TO READERS AND CORRESPONDENTS.

JOHN BELL, London.—If he has commenced the study of the work he mentions, he had better continue it. Unless we knew his mathematical position, we could not advise him upon the choice of a guide; but this is very good.

J. A. P. Newcastle.—Sulphate of copper may be produced by boiling concentrated sulphuric acid upon the metal in an iron vessel. It is produced naturally in many copper mines, resulting from the infiltration of water over copper pyrites, which has become oxygenated by atmospheric exposure. It may easily be made in small quantities.

JOHN, Birmingham.—We have received his second enclosure of sketches, and are still of opinion that the idea is identical with Mr. Johnstone's. For a description of this invention see the Practical Mechanic's Magazine, vol. iii. page 407; also, vol. ii. second series. If he does not agree with us, let us hear further. We have not the slightest doubt as to his originality of invention: the same thing may occur to twenty parties.

J. EDGAR, Newry.—Our reply to his enquiries as to the stone-cutting machine has been returned to us through the Post Office. The machine did not answer.

R. HEDLEY, Middlesboro'.—Has he received our communication? We wait his reply to it.

W. R., Aberdeen.—The scheme appears to be quite practicable if divested of its complexity. Some of the motions may be obtained with half the gearing he shows.

J. H., Sheffield.—If he will send us an account of his apparatus, with drawings, we shall be glad to notice it.

H. CHILDS.—He should register his invention. Until this is done, it is worth nothing, as the invention is not *property* in the eye of the law.

THE LITERATURE OF ENGINEERING.

We have for some time proposed to discuss the subject of engineering literature. This subject has been brought prominently forward of late, from the circumstance of the publication of an elaborate account of the erection of Skerryvore Lighthouse; and we believe that it deserves a word or two of consideration.

The interest attached to the literature of engineering increases, of course, with the increase of works of engineering. It is a matter of common complaint, that our engineers are generally averse to the publication of their works. One would imagine that the greatest engineers ought not necessarily to be the least inclined to make known their professional performances. Their position sets them above the fear of rivalry, and, were it only to explain to the world how they have laboured for the fulfilment of their conceptions—how they have met and overcome every difficulty which interrupted their progress—they would at least be rewarded with the intelligent admiration and gratitude of their fellow-men. As a mass, engineers are not, in private, reluctant to make their works known and understood; but, propose to carry the history of their works before the public, and they will at least evince indifference to the proposal, and probably inform you, that the general class of readers who patronize publications of the kind are not those who are to benefit by them, and that therefore it is useless to lay before the public what the public really does not want. They will perhaps add, that it is not wisdom to let the public know too much, on the exploded maxim that a little learning is dangerous. The fallacy of this argument is transparent. The very cause of the common neglect with which engineers are accustomed to regard professional publications generally—and here we have more especially in view periodical publications—is to be found in the nature of their contents. By embracing too wide a range of subjects, touching on all, and mastering none, they acquire a character of pretension, combined with meagerness, which is certain to end in failure. Render them valuable to the professional man, by making them repertories of complete, circumstantial, and accurate accounts of the works which they notice, and he will no doubt acquire a habit of referring to them as to a ready reckoner, as a ready means of solving laborious problems. There have been, no doubt, some conspicuous exceptions, both among books and periodicals, not falling under the above outline of description. But, generally, it will be found that the decline and fall of professional publications are to be attributed to the diffuseness and irrelevancy of their contents, and the attenuated thought which necessarily characterizes them. The independent power of engineering publications to establish a footing for themselves has been too well exemplified to require any confirmation at our hands. The Reports of quaint old John Smeaton were among the first published of those repertories of genuine experience to which we refer. To those who have read and studied these Reports, we need not say that they possess all the interest which is supposed to be the prerogative of works of romance. In these papers, Smeaton has conferred a lasting obligation on his successors, and he has also laid an enduring foundation for his own fame. The last of the engineering books of the same class is Alan Stevenson's work on the Skerryvore Lighthouse, and on the Illumination of Lighthouses. This work has been hailed with cordial approbation by the whole periodical press, as a rare contribution to professional literature; and when we reflect on the multitude of anxieties, hopes, and joys, that were alternately allayed, blasted, and realized, in the course of the erection of that most stupendous of lighthouses—when we reflect also on the multitudinous details with which the work is replete—we can hardly accord a sufficient welcome to this production of Mr. Stevenson's as a rich accession to our libraries. It has been done well, and what is better, quickly done.

It would be difficult to exaggerate the importance of professional papers of the circumstantial character to which we have reference. Such papers can only be sufficiently elaborated under the special superintendence of the engineers of the works under description. There are numberless experiences which are only matter of memory, and are therefore nothing more than traditionary. Were all these tributary rills of experience carefully collected and systematized, in place of being left to run wild, and lose themselves in the sands of the memory, they would ultimately join into one considerable stream: several streams thus formed would, when united, constitute a river; and, to continue the figure, we all know that rivers in their united strength are the means of forming seas. As every engineer's experience is founded on natural principles, all experience would be certain to harmonize ultimately, and by sure degrees to form one vast body of standard engineering practice, whence some capable mind could educe a system of engineering institutes. The benefit of such revelations of professional experience would extend to the compeers as well as to the successors of their authors. By learning what has been done, how it has been done, and why it has been done, the engineer acquires invaluable lessons for his own direction. He learns what to avoid as well as what to imitate. After works of construction are completed, nothing remains to announce to the observer the peculiar difficulties which had to be surmounted. Even should the works be works for all time, they lose a great part of their value as lessons in engineering; for the ways and means that prove the skill of the engineer, and that had been brought to bear upon their construction, are all removed from the sight, or as thoroughly concealed in the work as the foundation stone itself. In contemplating the Conway Bridge, who shall gather from the structure more than a general impression of the boldness of the engineer who framed the first conception of it? Or who shall understand to what degree we are indebted to the masterly series of experiments, originated and conducted by Mr. Fairbairn, for the verification of the principle aimed at by Mr. Stephenson, and for the discovery of the principles upon which the precise form and dimensions of the great tube were established? Or who shall inform us, from an ocular survey of the sublime railway bridge of Ballochmyle, with its unrivalled semicircular arch, of the principles which guided Mr. Miller in the selection of this means of spanning the ravine? Now, when those great works are accomplished, every vestige of difficulty, or of ways and means, is carefully removed, and nothing but the ideal objects as they existed in the minds of the engineers are left as pledges of engineering ability.

Such is the general argument for the importance of the publication of works on engineering practice. We cannot expect it to have much weight with the members of the profession, so long as they are actively employed in the discharge of their duties. It is at least to be hoped that, in the days of their retirement, they may be induced to engage themselves in their leisure hours upon what ought to be labours of love. To those who have tasted the pleasure of successful authorship, there appears reason to look for such written works. Nor is it to be regarded as a business of any great difficulty to produce a practicable volume of practical matter. Engineers, no doubt, are mostly in the habit of working out their plans with only a mere technical specification to show as a literary production. But they have the material—for which they have only to draw upon their ready experience—for producing works of the utmost value;—a state of things very different to what we commonly find in professedly practical works. They are not mere compilations of specifications and engravings that constitute the desideratum. We must have also a detailed account of the progress of the work specified and illustrated, with all the apparatus and other means employed. The world is now too old to tolerate the mystery of clannish craftsmanship which once existed. There still remains, nevertheless, a considerable feeling of exclusiveness. The folly of such limited policy is obvious when we know that every public work must, of course, finally stand before the public at large. It is also a public injustice, for the greater the artificial difficulty of acquiring an acquaintance with such works, the more partial must be the progress of improvement. And although, for purposes of individual aggrandisement, it may occasionally be successful, we believe

the loss is generally equivalent to the gain; for he who insists on secreting his own produetions from the publie, loses the henefit of their eriticism, and cannot expect mueh in return from his brethren, in cases where reeiprocity would be advantageous. We feel certain, that, were the knowledge of every engineering design of importanee eirculated freely among the profession, every member would be relatively in the same position that he would oceupy under a eontrary poliey. The same talent whieh produees good things, will be able, in the same proportion, to reeognize and appropriate what is good in the works of others. Where the influenee of this general law may be supposed to terminate, the pateut law offers itself as an expedient for the proteetiou of original inventions. It must he eonfessed, however, that the patent laws, as they are, but elumsily operate as the expedient now eontemplated; for the less affluent members of the profession, they are nearly ineffieaeious. They have not the fine adaptability to individual eases whieh we are entitled to expeet. Under the existing eode of eharges for letters patent, this blind law recognizes the money value of the inventor, and loses sight of the invention itself. With an aeute discernment of what is for the immediate benefit of the exchequer, and the grossness of taste naturally assoeiated with sueh an ohjeet, the patent laws do not reeognize the delieaey of genius—they allow not its claims to compete with the neediness whieh gave them birth.

Of all the text-books and guides for the use of engineers—we mean meehauieal as well as eivil engineers—there are many whieh do not satisfy even the most moderate expectations, and possess hut slender claims upon our attention. On the footing of one or two original works, nearly the whole brood of reference books are eomposed. There being little originality either in design or in contents, the errors and defeets of the originals are perpetuated. The practice of engineering is eonstantly varying, and therefore we ean have no stereotyped reprints of books whieh profess to be guides. The scraps of information with whieh we are favoured in these classie books, and the want of what we occasionally most require, demand that sueh ancient productious be superseded by publieations of a new sehool, adapted to the modern modes, which shall evinee, not a design to make hooks, but an appreciation of the present wants of engineers. Of the works of the new school, we may partieularize Mr. Bourne's Cateehism of the Steam Engine, whieh, though it is liable, like the rest of Mr. Bourne's produetions, to the eharge of want of arrangement, is a step in the right direction, and is deeidedly in advance of all others of the same class in point of praetieal utility. It eontains, in a eondensed form, the most modern praetice of steam engineers.

In perusing the "Prineiples of Architecture and Engineering," hy Professor Moseley, we do not fail to admire the copiousness of the author's demonstrations, and the great command of the calculus whieh they exhibit. The work is quite an achievement as a mathematieal expositiou of eertain forees operating in arehitectural and engineering structures. We feel eertaiu, however, that little is to he gained by Mr. Moseley's investigations, whieh eannot be aseertained hy ordinary modes of caleulation. There are many eireumstances which either are not or cannot be taken into aecount, in completing the analysis of forces aetive in buildings and other works. Nevertheless, the absenee of those elements among the data on which the investigations are founded, very much iuvalidates their usefulness as furnishing rules for practice. Sueh investigations have been found frequently to mislead. It may be said that they convey at least correct general ideas, though, if they be incomplete, they can hardly he correct; at all events, the most useful eonelusions can generally be arrived at by simple ealculations derived from very elementary considerations. Let us turn to the first example in Mr. Bourne's hook that oecurs. At page 192, we find that a large cast-iron eylinder will inevitably become oval by its own weight, if laid on its side; and if, while under the tension due to its own weight, it be bored round, it will beeome oval again when set upon end. Every mechanic understands the simple reason of this change of figure. Mr. Bourne informs us that ordinary meehanics, to prevent sueh an oeeurrence, carefully guage the eylinder when standing on end, and set it up by screws when laid in the mill, till it again assumes its original form. This is the method of doing a plain thing in a plain way. Were the man at the boring mill a professed mathematician, he would probably set about an analysis, the objeet of whieh would be to determine, *a priori*, the preeise form of the oval, with the amount of its eeeentrieity, that he might provide for its reetification. However earefully he might assume his data, it would be impossible for him to determine, by analysis alone, the preeise figure of any individual eylinder under the eireumstanees supposed, owing, amongst other things, to the variable nature of east-iron. Without aeeomplishing this, his calculations must be useless to him; and he had mueh better apply the guage at onee, kuowing that in doing so he would do well, let those do hetter who eould. We quote this imaginary example to show how easy it is for a mathematician to theorize, and to how little purpose.

Mr. Armstrong's work on Steam Boilers, puhlished some years ago, although of small dimeusions, is another example of the useful class of works whieh derive their authority direet from experience. In this book, the author reeords his experimental ohservatious on hoilers, and dips very sparingly into mathematieal discussion. He diseourses with feeling on the efforts of mere theorizers to improve the effieieney of the boiler by huilding interminable flues, and hy other deviees for abstraeting "ealoric" from the smoke. It did not oeeur to these men of a single idea, that, in lengthening the flue, they spoiled the draught. One would think they expected to manufaeture heat in their anxiety to use it all up. Mr. Armstrong set them right; he showed them that they eould not abstract the heat entirely from the smoke—at any rate, that they could get no more than the whole of it.

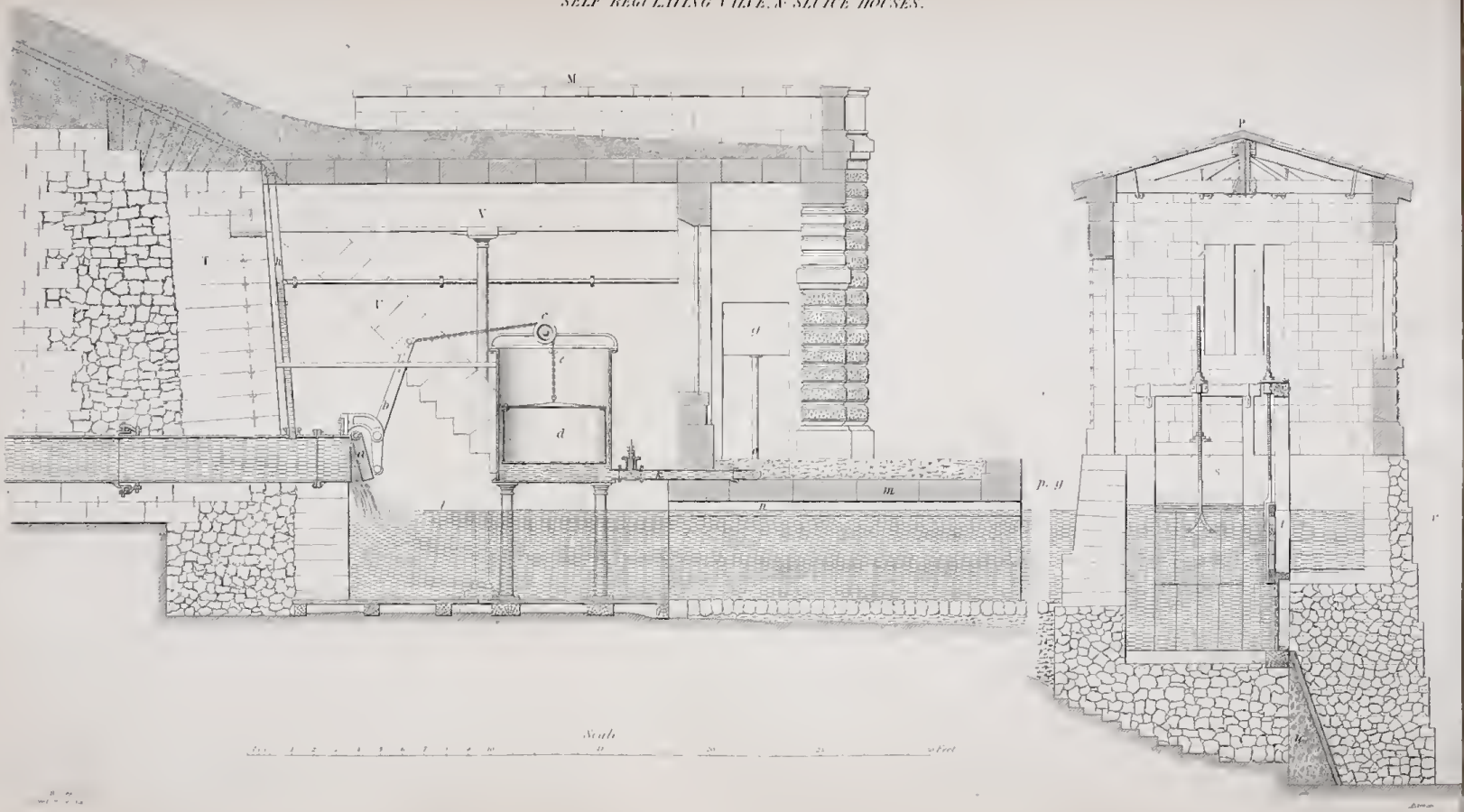
The works of the celebrated Holtzapffel, of revered memory, are illustrious examples of the kind of publications we now advocate. They are, we feel warranted in affirming, perfect examples, so far as they have been published, of what sueh works shonld he, paeked with praetieal matters, all hearing on the main subject, and systematieally arranged in natural order. We have only to hope that a work so gloriously commeneed may he continued and completed in the same style, by the sons and sueeessors of the late author.

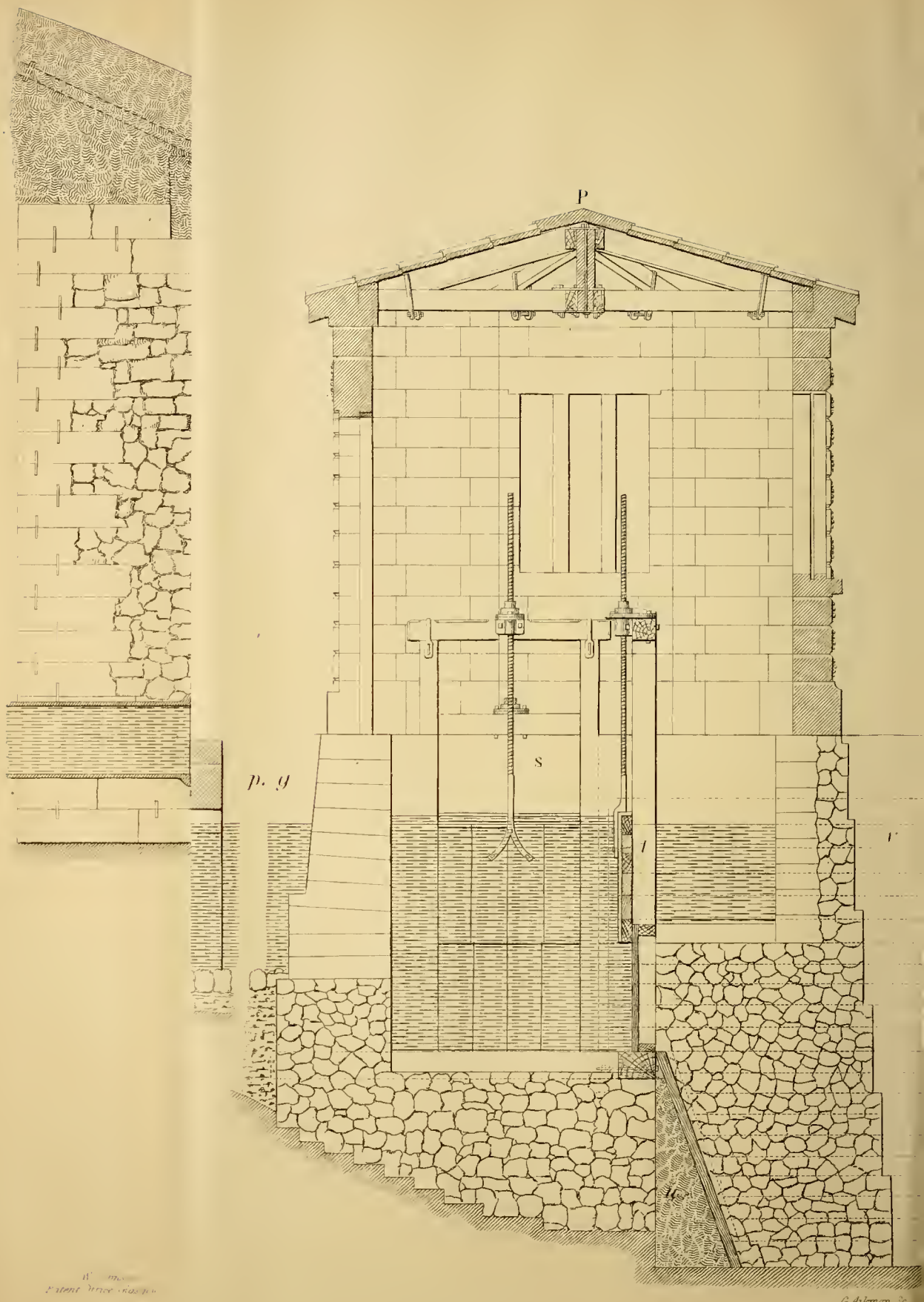
In Willis's Principles of Mechanism, we have a work professing to form a seience of meehanism, or system that embraces all the elementary combinations of meehanism, admitting of a mathematieal investigation of the laws by which their modifications of motion are governed. The author sees no reason why the construetion of a machine for a giveu purpose should not, like any usual prohlem, be so redueed to the dominion of the mathematieian, as to enable him to obtain, by direet and eertain methods, all the forms and arrangements that are applieahle to the desired purpose, from whieh he may seleet at pleasure. The Professor deserves much credit for the resolute manner in whieh he has executed the task he has assigned to himself—that of redueing the elements of meehanism to a system. The system is one of great beauty, and deserves at least the distinetion of being a natural one. It is to be doubted, however, if praetieal meehanism—we do not say the *science* of meehanism—will be much advaneed by such means. It may be a very good work for the universities, but we doubt if ever the construction of a machine will be, like any usual problem, reduced to the mathematician's code of laws. There is no royal road to invention. Indeed, the Professor admits that there are many considerations of force and arrangement which must be entered into before the machine can be completed. Every mechanical engineer knows that these are the most important considerations. The whole history of the locomotive engine, for example, may be resolved into considerations of force and arrangemeut. It is easy, and, what is more, it is quite in good time, to systematize after the materials for the system have heen supplied.

The truth is, we have had enough of principles, elements, poeket-

GORBALS GRAVITATION WATER WORKS.

SELF REGULATING VALVE & SLUICE HOUSES.





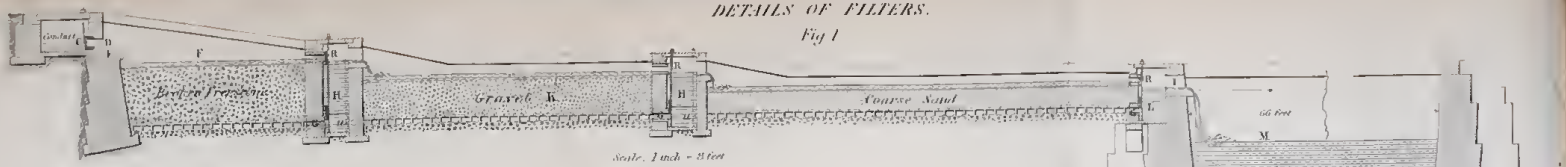
Patent Office Museum.
G. Adams, Sc.

Plate XIII

CORBALS GRAVITATION WATER WORKS.

DETAILS OF FILTERS.

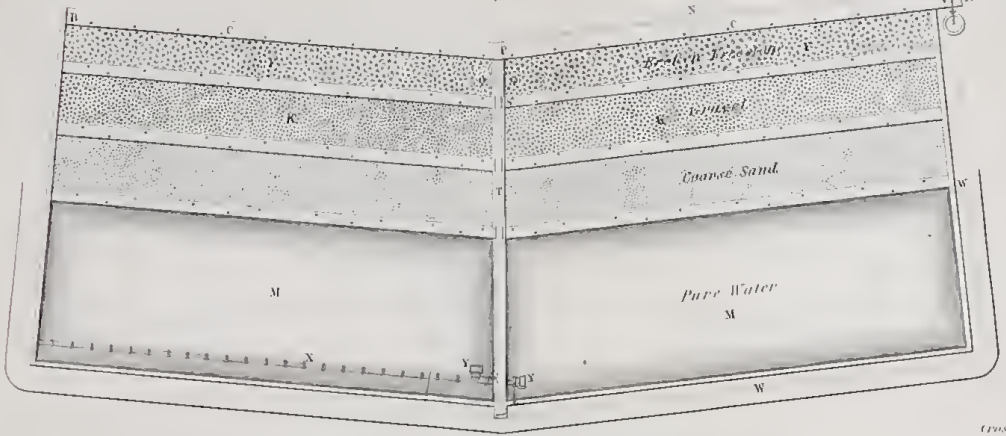
Fig 1



Scale, 1 inch = 8 feet

Cross Section of Conduit at back of Filters

Fig 2.



1 inch = 40 feet

Fig 3

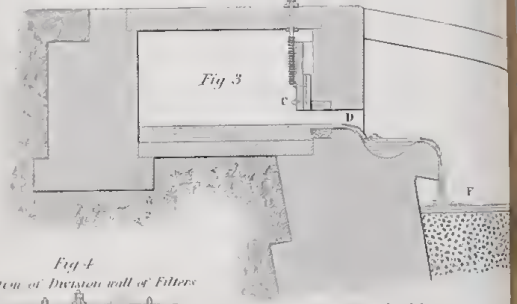


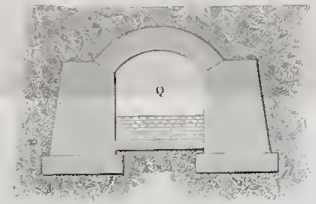
Fig 4

Cross Section of Division wall of Filters

1 inch = 4 feet

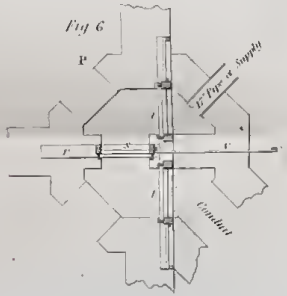
Fig 5.

Cross Section of Conduit

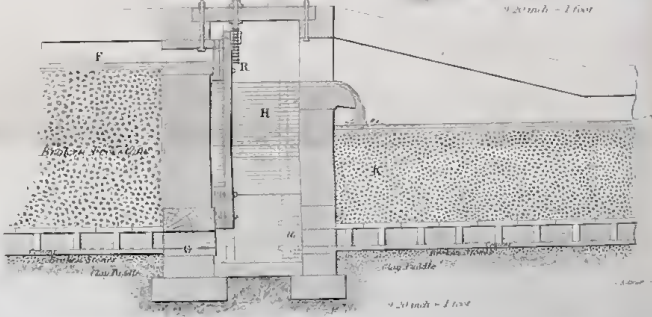


1 inch = 4 feet

Fig 6

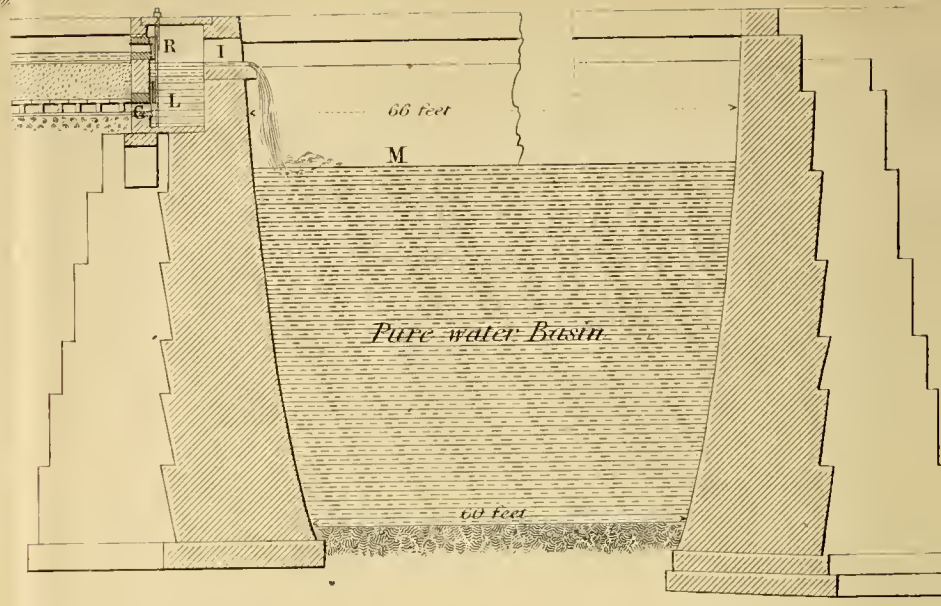


1 inch = 8 feet



1 inch = 4 feet

Plate



Cross Section of Conduit at back of Filters

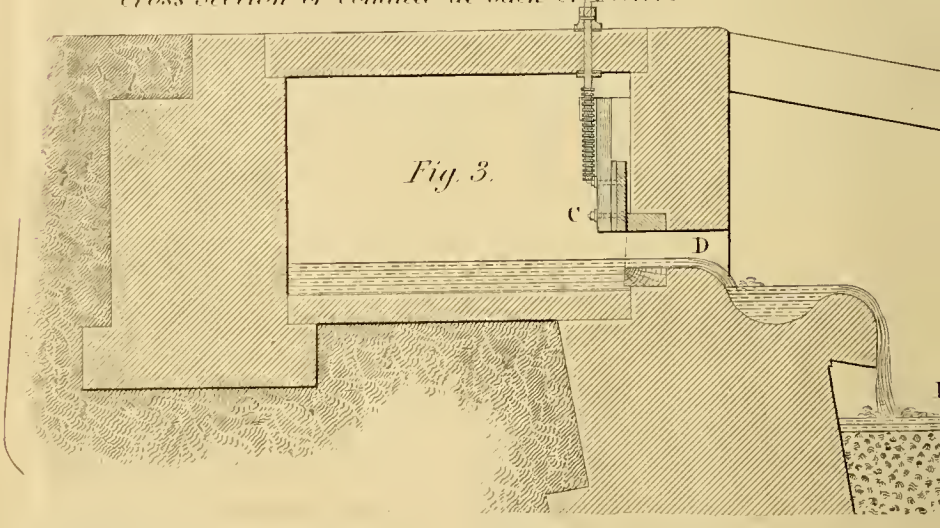


Fig. 3.

guides, pocket-hooks, and commonplace hooks,—very commonplace indeed. We have had the everlasting story of the five powers in every hook written since Archimedes was a boy. It is high time that this hook-making business were ended, and the proper wants of the engineer supplied. We take this opportunity of appealing to our readers, and of impressing upon them the necessity for each of them, according to his opportunities, contributing his quota of practical data. There are many valuable items that only require to be gleaned and stored in the periodicals of the day, to become useful. We should thereby render our Journal a storehouse of facts, contributions towards the establishment of a systematic practice. We beg to submit that our readers should feel themselves, all and severally, interested in the welfare of this Journal, and were they generally to communicate their experience as it occurs to them, even in detached paragraphs, it would be difficult to over-estimate the importance of such contributions.

One word of explanation as to the use of mathematics in engineering. We can by no means object to mathematical discussions of engineering subjects, where applicable; but we do object to the affectation of mathematical accuracy, where, from the nature of the subject, it is unattainable. It is no less true than strange, that while mathematics can pierce the very heavens, and most accurately determine the principles of the motions of the heavenly bodies, they cannot reach the law of the elasticity of plain common steam at different temperatures. The most correct rules for steam are at best empirical, and are directly derived from experiment. What we want is, that symbolical mysticism be discharged, and that the mathematics of engineering be only so far cultivated as they are directly advisable. He is a wise man who knows how to apply his mathematical knowledge, and how to correct it by his experience. It is a two-edged sword, that will cut both ways—a capital servant, but a bad master. Useful mathematics for engineers are for the most part simple. In working our way with mathematics, we cannot long trust them unchecked by experiment. Very few inventions in engineering have been the result of any great mathematical acquirements. Even in James Watt's inventions, to which everybody is fond of recurring, nothing of mathematical tact is to be traced as the leading inventive faculty. His was the true genius, which sees things naturally that are not at the same time obvious.

PRACTICAL NOTES.

WATER SUPPLY OF LARGE TOWNS.—THE GORBALS GRAVITATION WATER WORKS.

Illustrated by Plates 12 *and* 13.

[Concluded from page 99, August.]

The self-acting arrangement, by which the discharge of water from the two main reservoirs is regulated, is ingeniously simple, and admits of the greatest nicety of adjustment of the supply to the demand, whether for the filters or the compensation stream. Plate 12 is a vertical section of the house, M, containing the apparatus, and the octagonal building, P, in which are placed the discharge sluices from the regulating basins, *p q*, as detailed in the woodcut fig. 5, in our last article. The house, M, is built into the embankment of the lower reservoir, the retaining wall, T, of which forms the end wall of the house. This wall is of rubble, faced on each side with large ashler stones, batted to each other with metal bats; the inner side being built of radiating ashler stones, and is further supported by a rubble buttress wall, U, with a curved sloping face of ashler. The roof of the house is formed by three 12-inch free-stone arches, the two outer ones springing from the two side walls, and being supported in the interior by two longitudinal cast-iron beams, V, running across between the back and front walls, and supported in the middle by two cast-iron pillars. The top of the arches is covered with a flat layer of clay puddle, to a depth of ten inches over the crown. Four archways conduct the water beneath the front of the house to the two basins, *p q*, which are shown broken away in Plate 12. These basins are of ashler, with a freestone rubble bottom set in flat banking upon the sloping face of the rock foundation, and are separated from each other by a central wall, four feet in thickness, leading to the door of the octagonal house, P. The water is conducted into the interior of the house, by two entrances opening direct into the inner corners of the basins. The bottom of the house is composed of 6-inch droved flag, and answers as a discharging cistern for the water, being fitted with sluices for each delivering channel. The detached plan of the house, P, (plate 12, fig. 6,) shows the general arrangement of the sluices. A central division of timber, *r*, prevents the mixing of the water from the two basins, *p* and *q*, but the two may be connected at any time by a sluice, *s*. A second timber division passes across the house at right angles to the former one; and in this division, the two sluices, *t t*, respectively leading off the compensation water and supply, are placed. A layer of clay puddle, protected by sheet piling, passes along the front of the sluices at *u*, for the purpose of preventing the percolation of the water; and the central division wall is rendered impervious by a 2-inch frame of boarding, *v*.

According to the terms of the Company's Act, 9½ cubic feet of water per minute is to be run off by the pipe leading to the Brockburn, at S, below the works, for every ten million cubic feet which is impounded in the reservoirs; and by means of the regulating basins, the cubic content of which is accurately known, this supply may be regulated, and the actual delivery tested by a simple filling and emptying of the basins.

The filters and settling basins, R, have been formed on the brow of a hill, at a distance of about 1000 feet from the sluice-house, P, the water being carried along the sloping surface of the ground by an arched stone conduit, Q, which follows the contour of the hill, and is laid on a perfect level. Plate 13 exhibits a sectional elevation, ground plan, and details of the filters. Fig. 1 is a transverse section of the three filters, and terminal pure water basins. Fig. 2 is a complete plan of the whole, drawn to a smaller scale. Fig. 3 is an enlarged transverse section of the conduit, where it passes behind the range of filters; and fig. 4 is a transverse section of the division walls running between each filtering bed.

The conduit, Q, a transverse section of which is given in fig. 5, is built throughout of stone, the bottom being evenly floored with flags. It is arched over with a 12-inch stone arch of 26 inches radius, the crown of which is 12 inches below the natural surface of the ground. The filters are divided into two ranges, each with a coarse, medium, and fine filtering bed. In order to take advantage of the natural curvature of the hill, and to avoid the construction of additional embankment, the two ranges have been set at a considerable angle, so that neither end projects beyond the hillside. The conduit joins the back range at A, where a self-acting sluice is placed; thence it passes alongside the back wall of the coarse filter, terminating at B. This portion of the conduit is covered over by 12-inch flags, through which the screwed rods of a series of sluices, c c, project, with adjusting nuts at the top. Each filter is fitted with ten sluices. The openings in the conduit wall, D, are long and narrow, and the water issues through them in a thin sheet, gliding gently into the longitudinal concavity of the stone coping at E, whence it falls over the rounded lip into the first or coarse filters, F F.

The whole of the graduated line of filters are alike in their general construction, the only difference being in the relative fineness of the mass of the filtering bed. The bottom of each, after being well levelled, had a layer of small stones or very coarse gravel beaten into it, to give it a surface fit for the reception of a layer of cement one inch in thickness. Upon this cement floor, rows of bricks are laid on edge, 10 inches from centres in the row, and one inch apart longitudinally. These form an open groundwork for a flooring of square perforated tiles, laid in unbroken connection. Each of these tiles is 10 inches square and 1 inch thick, perforated pretty closely with holes about ¾ inch in diameter. The filter bed is then filled in upon the tile floor, with broken freestone about the size of macadamized road-metal, which has been found by experiment to be the best material for the purpose, being much superior to any kind of gravel or coarse sand as a primary filter.

The water, in falling, spreads evenly over the surface of the freestone fragments, and gradually percolates through the perforated tiles, and finds its way by the interstices of the supporting bricks, to the cement floor at the bottom. Here it is on a level with a line of narrow sluice openings, G G, (see also the enlarged section, fig. 4.) By these openings, it passes to the bottom of the drains, H H, contained in the division walls, where any sediment which may have been carried over with it, is deposited, and the pure water rises in the basins, to the level of the line of discharging openings at I, through which it pours in a thin film, on to the bed of the second or gravel filters, K K, through which it percolates as before. The process is repeated throughout the three filters, until the water arrives at the last settling basins or drains, L, whence it passes into the pure water basins, M, from which the supply-main for the town is fed.

The bottom of all three filters is on the same level, but the upper surfaces of the three are graduated, so as to admit of a gentle flow of water from one to the other. The broken freestone in the first bed, is in pieces of the size of road-metal, and it is found to answer admirably in clearing

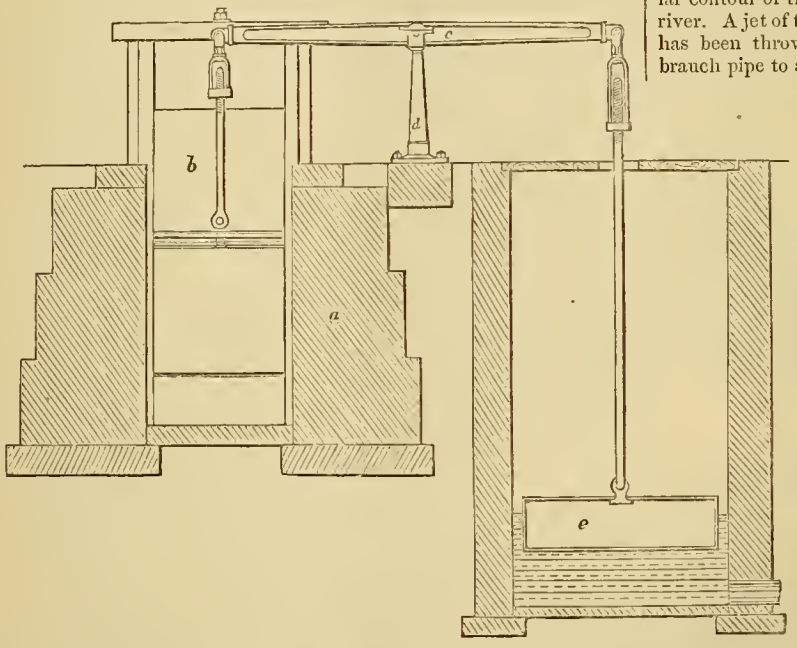
off the grosser particles of the water, whilst its extreme porosity admits of a quick action, and renders the operation of cleaning a very easy one. The material of the second bed is riddled gravel. The third, or finest filtering material, is coarse sand, from the larger Cumbrae island in the frith of Clyde.

The duplex arrangement of the filters admits of an easy system of cleansing, without interfering with the due operation of the works. A six-inch line of pipes, N, is laid down to bring a supply of water from the conduit at O, to the bottom of the central division wall of the filters at P, whence a stop-valve branches off into each of the first filters at Q Q.

The object of this is to obtain an upward current of water through the filtering medium, so that the impurities which have been detained in it may be carried up to the surface of the bed, and floated off into the drains. Previous to cleansing the bed next the conduit, the whole of the under sluices communicating between that bed and the adjoining drain, are shut by their adjusting nuts on the top of the drains. This movement at the same time opens the upper line of sluices, R R, both sets being attached to and worked by the same spindle; and the stop-cock, Q, being opened, the water flows into the bottom of the bed, and as it finds no means of escape by the closed sluices, G G, it flows upwards, and passes through the upper sluices, R R, into the drain, whence it is conducted by a sluice at S, into another drain, T, shown in dotted lines in the central division wall, fig. 2.

The second and third beds are cleansed by a similar upward current, obtained by opening the range of bottom sluices, U, represented in dotted lines. A line of these sluices is placed in the interior of the drains on the opposite side to those formerly mentioned, and by raising them, the water from the drains is allowed to pass into the bottom of the beds, and finds its way up and over the top, as before explained. The supply to the filters is regulated by a self-acting sluice placed at Y, where the conduit joins the filters. The wood-cut, fig. 1, explains the action of this

Fig 1.

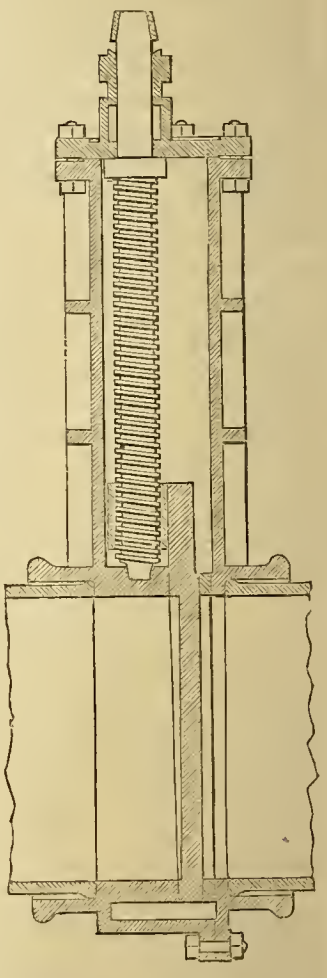


sluice: *a*, is a transverse section of the conduit, with the sluice, *b*, which is connected by an adjustable link, with an oscillating beam, *c*, jointed to the top of a short pillar, *d*. The contrary extremity of this beam is similarly connected to a hollow wrought iron float, *e*, which is acted upon by the water in a well in connection with the two pure water basins. As the level of the water in the basins is elevated or depressed, a corresponding change of level takes place in the well, which communicates with the two basins by the pipes, w w. By this simple arrangement, the delivery of the conduit is accurately regulated, and the rising or falling of the level in the conduit stream, is felt throughout its whole length, and acts upon the floats of the other self-acting arrangement above the regulating basins shown in Plate 12. The float, *e*, thus serves the double purpose of regulating the delivery from the reservoirs to the regulating basins, and the delivery from the conduit to the filters.

The line of 24 inch pipes, conducting the supply of water to Glasgow, is represented at X; slide-valve sluices are placed on the pipes in each basin at Y Y, and strainers of fine copper-wire are attached to each sluice, through which the water is passed, previous to its final escape. The track of the pipes is through the village of Pollockshaws, and the full-sized main is continued onwards, until it arrives at the point of divergence of the two roads, leading respectively to Glasgow and the Stockwell Bridges, when it divides into two lines of 17 inch pipes, one passing down each road.

The species of slide-valve sluices employed in the main line of pipes is represented in fig. 2. The two extremities of the pipes upon which the valve is placed, join up in a double socket, cast on the end of a vertical oblong box, which receives the slide of the valve when open. The lower end of the screw-adjusting spindle rests in a recess in the upper side of the socket, as a footstep. Its connection with the slide is by a brass nut fast on the upper end of the slide, through which nut the spindle passes. In this way, the slide may be raised into the recess above it, by the application of a key to the upper end of the screw-spindle projecting above the valve-chest. The capability of delivery of this pipe is about 9000 gallons per minute, or 13,000,000 gallons per day. The 220 feet elevation of the pure water supply basins will admit of service supplies to the inhabitants at least 190 feet above the level of the Broomielaw Quay, being very much higher than can ever be required in the Gorbals district, where the levels of the streets vary to no greater extent than 40 feet, the surface of the ground being quite flat as compared with the hilly and irregular contour of the north side of the river. A jet of two inches' diameter has been thrown from a five-inch branch pipe to a height of 100 feet. Several fires have been extinguished by means of a jet alone, fire-engines being rendered quite unnecessary.

Fig. 2.



The Parliamentary estimate of cost of these works was £91,550, and as they are all but completed, there is every reason for stating that this sum will not be exceeded. The water was first passed through the pipes on the 1st of March, and on the 1st of June following, it was supplied to 50,000 of the inhabitants, producing a revenue of £4500.

The excellence of the water, and the abundance of the supply, has led the directors of the company to consider the propriety of extending their supply to the whole of Glasgow; and recent surveys have shown that, by constructing additional reservoirs higher up the hill upon which the present works stand, a supply for a population of 750,000 may be obtained.

THE ATMOSPHERE.

We denominate that envelope of gaseous particles which floats above and around our globe, the atmosphere, or the region of air. Up to a recent period the air was reckoned an elementary body, but modern chemists have shown that it is capable of analysis, and that it consists of two ingredients, oxygen gas and nitrogen gas. The proportions of the admixture is about 21 parts of oxygen, and 79 of nitrogen. The

properties of these two vapours are quite opposite. Oxygen is the basis of almost all the acids, the feeder of the blood in the process of respiration, the supporter of flame. No animal can exist in any air of which oxygen is not a part. Nitrogen, on the other hand, extinguishes both life and flame. After the oxygen has been abstracted from the inhaled atmosphere in the lungs, the nitrogen is rejected. It is a little lighter than common air, and consequently oxygen is a little heavier. At the temperature of 60°, and with the barometer standing at 30 inches, 1000 cubic inches of dry atmospheric air weigh about 310 grains. A similar quantity of water under similar circumstances weighs 252,525 grains, that is, water is above 800 times heavier than common air. The exact height of the atmosphere is not known, but it has been found that a column of it one inch square, presses with a force of fifteen pounds on the earth's surface. As the air is an elastic fluid, its lower strata are more dense than its upper, in consequence of the pressure from above. Its elasticity may be proved in this way:—place a loose and nearly empty bladder, with its mouth firmly tied, under the receiver of an air-pump, and exhaust the air; as the pressure of the atmosphere is removed, the small quantity of air remaining in the bladder will expand, until it appears completely filled. As the air is again admitted under the receiver, the bladder will resume its former empty appearance. The principle of the barometer is this: mercury, when placed in an upright tube of glass, from which the air has been abstracted, will mount upwards, until its column equals in weight the weight of a column of air, from the surface of the globe to the limits of the atmosphere; for this reason, that there is a pressure on all sides of the mercury, except immediately above it (the air having been withdrawn from thence), and the mercury is thus forced upwards. Now, if we carry the instrument from the earth's surface to the top of a mountain, the pressure being here less, the mercury will sink in its tube; and if we carry it into a mine, the pressure being greater, the mercury will rise. These experiments will serve to show both the weight and elasticity of the air. We may add, that it has been calculated that the body of an ordinary sized man, has to sustain a weight of about 32,000 pounds of air, and that the surface of the globe is pressed by the same invisible fluid, to the enormous extent of 5000 billions of tons. The equality of the pressure, that is, the pressure on every side of the same particle of matter, at the same instant, will give the reason of no injury resulting from this immense force.

These two properties of the atmosphere are of the greatest possible use to man in compassing his ends by mechanical contrivances. He has turned them to his purposes in some of the simplest and in some of the most complex of his machines. The ascent of the mercury in its tube—the lifting of a stone by a boy's sucker—the conveyance of liquids from vessel to vessel by the syphon—the extraction of blood by the process of cupping—the drawing up of water by the common pump—the forcible ejection of it from a fire engine, and the complete working of the steam-engine, are all connected with the pressure and elasticity of the air. And so in a thousand processes of nature herself, she makes use of these properties, as may be instanced in the adherence of the limpet to its rock, in the power the common fly has of walking along a vertical smooth surface like glass, and in the respiration of animals.

The height of the atmosphere has never been accurately determined, and probably cannot be so. There seems reason for supposing it to be 200 miles at least in altitude, and yet some naturalists believe that the extreme limit is not more than 50 miles distant. On the other hand, the theory has been started, that an elastic fluid fills all the regions of space, and that the heavenly bodies attract to them a greater or less portion of it according to their mass. But it is extremely difficult to agree with any such conjecture, since it supposes that the inhabitants of other spheres breathe the same kind of air as ourselves, and it would appear to receive a direct contradiction from the fact that the earth's atmosphere revolves, as if attached to it, without any current being occasioned in the opposite direction, as would inevitably be the case if the revolving air were only a part of an ocean of vapour. On the other hand, it seems probable, from observations on the motions of comets, that there is some subtle medium filling the spaces through which they travel that perceptibly retards their movements, but it does not follow that such medium is formed of atmospheric air.

Not only is the density of the air less the higher we ascend, but its temperature decreases also. Gay Lussac, at a height of 7634 yards above the sea, found the temperature less by 70½° than at the surface, and if the decrease be on a uniform scale, we should have a degree of Fahrenheit lower at every 105 yards of altitude.

The functions of the atmosphere in the economy of the globe are various and important. Even in its driest state, it holds water suspended in it, the quantity varying with the season, the height, the hour of the day, and the latitude. By its means, the process of evaporation is effected. The vapour which the heat of the sun and other causes carry upwards from the earth is formed in the higher regions of the atmosphere into clouds. It is stated that 1000 gallons of water will evaporate from a single acre of ground in the course of twelve hours, and that, at the time of its dispersal, the vapour occupies a space 1400 times greater than water. The quantity thus drawn from the surface of land and sea in every twenty-four hours must be inconceivably great. This vapour is returned again in the shape of dew, rain, snow, &c., supplying the ground with fertilizing moisture, and the rivers with means to continue their existence. When the vaporous matter is first drawn off, it is much lighter than the air in which it is suspended, and it accordingly ascends until it reaches a stratum of equal density, where it condenses into clouds. There it remains a sport for the winds, which may drive it a thousand miles from the place where it was formed, until a change in the temperature, or some other cause, again precipitates it to the earth. Clouds are stationed at various heights in the air; sometimes they are as high as four or five miles, at others they are low enough to touch the tops of steeples, trees, and similar objects, and then they appear to us as mists or fogs. Clouds have been divided into seven classes, according to their shapes. *Cirrus*, a light cloud, like a feather or a lock of hair. It has the highest position of any, and has the greatest variety of shape. *Cumulus*, a cloud of denser composition, increasing from above. *Stratus*, having a mean degree of density continuously extended in a level sheet, and increasing from beneath. *Cirro-cumulus*, a sort of compound of the first two, a collection of rounded clouds placed in close contact. This is a summer cloud, and makes a pretty sky. *Cirro-stratus* has usually the form of horizontal layers, restlessly changing their figure and position. *Cumulo-stratus*, in which the cumulus is mixed with the two last named kinds. It has been compared to a mushroom with a very short thick stem. The *Nimbus* is a dense cloud, the top of which is shaped like cirrus, and the under part of it passes into rain. Clouds are frequently made the recipients of a large quantity of electricity, and when a cloud which is charged comes into contact with one that is empty, a transfer is instantaneously effected, and lightning is the visible passing of the fluid. The quantity of rain let fall by the clouds varies with the latitude. In tropical climates, where evaporation is very great, an enormous deposit of rain takes place. Thus, the mean fall of rain in England annually is 32 inches, whilst in the West Indies it is 120 inches. Snow is nothing but aqueous vapour frozen in its descent to the earth, and hail is a compacter kind of congealed water, coming from the higher strata of the atmosphere. Dew is a deposit of vapour taken into the air during the heat of the day, which, by the cooling of the atmosphere after sunset, can no longer remain suspended in it. In other words, the fine vapour which the sun raised and diffused through the atmosphere in a state, as it were, of solution, condenses, and is precipitated when the warmth which held it afloat ceases to operate. Hoar frost, which is seen covering the herbage with a fine powder on a winter's morning, is nothing but frozen dew.

A body of air changing its place, occasions wind, and this change of place is mainly brought about by a change of temperature. The phenomena of winds, originating in most instances at heights beyond our reach of accurate observation, are difficult of explanation. Winds are usually classed in three divisions, general, periodical, and variable winds. The first kind are those permanent currents of air which are often called the trade winds. They are found in all the larger expanses of water within 28° north and south of the equator. Halley has the merit of giving a general view of the phenomena attending these winds, which has been adopted by succeeding naturalists. When air becomes heated, it expands, becomes lighter, and, of course, ascends to a higher region; its place is immediately filled by the nearest cold air. The sun in its diurnal course rarifies the air to the extent we have named on each side of the equator, and in this immense space the rarefaction of the air and its replacement are the cause of the trade winds, which thus have a calculable regularity. The periodical winds termed monsoons blow for a certain time in one direction, and then veer round and blow in the opposite direction. Thus, along the Indian Ocean, the wind blows from the south during six months. Then comes the period of change, and violent blasts of wind, floods of rain, clouds, thunder and lightning, precede the blowing of the monsoon from the northward for the remaining six months. There are other periodical winds, which are known as land and sea breezes, occurring daily on the coasts and islands of tropical regions. During the day, the land becomes warmer than the sea, hence the air above it is rarefied, and its place is filled by a current from the sea. At night, the air resting upon the land becomes cooler than the air resting upon the sea, and therefore a current sets in the opposite direction. The variable winds have been chiefly remarked north and south of the tropics. Probably a more extensive series of observations will show that these currents of air are not independent of those already mentioned, and in time

39791

we may have the means of reducing them under some law. In these temperate climes we know little of the force which the unseen agent, air, is capable of exerting; it is in the neighbourhood of the equator where its overwhelming might is oftenest felt. Though winds have not seldom wrought a destructive influence upon life and property, their general operation is highly beneficial. They clear the atmosphere of noxious particles—they impel the clouds from the place of their formation to others where they can let fall their fertilizing drops—they aid the tides in preventing the seas from stagnating, by lashing it into motion—and man in his ships and his mills has derived immense benefit from the air, which he could not have done had its particles been always stationary

We have already alluded to the air as an essential part of the machinery of animal respiration. The lungs are two spongy bodies, full of many millions of minute cells, into which the blood is forced by the action of the heart, and there brought into contact with the inhaled air, from which it extracts the oxygen, and gives up at the same time a quantity of carbonic acid gas. When the blood arrives at the lungs, after having made the circuit of the body, it is of a purple colour; but, by the absorption of oxygen, it becomes of a brilliant red. It has been calculated that the quantity of surface furnished by the human lungs is 1500 square feet. Atmospheric air is no less necessary to the life of plants than to man. If confined within a vacuum, they wither away. Their leaves, acting like lungs, draw in carbonic acid gas, and throw off oxygen—a very beautiful regulation, since they thus supply man with the very gas he requires, and take up that which he rejects. Hence the policy of having planted squares and verdant plots in the centre of towns.

Air is also the medium of sound. Our organs of hearing would be perfectly useless, unless the vibrations of bodies were conveyed by vibrations of air into them, and thus produce the sensation of hearing. If the atmosphere were removed, and man was capable, notwithstanding, of existing, not only would he be deprived of all pleasures derived from sound, but he would no longer be able to converse, except by signs; an utter silence would reign over everything, and he would be a solitary in the midst of crowds. If a bell is rung under an exhausted receiver, it is inaudible; but, gradually as the air is admitted, its tones become louder and louder, so that it is clear that upon the elasticity and undulating motion of the air the existence of sound entirely depends.

If there were no atmosphere, immediately on the going down of the sun, the earth would be wrapped in intense darkness. Twilight results from the refraction of the air; that is, when the sun is a little below the horizon, either before his rising or after his setting, his beams catch the higher portion of the atmosphere, and its particles refract the rays of light upon the earth beneath. In this way we have gradations of light, and not all at once full day or blank darkness. Besides, whilst the sun is present with us, the same power of refraction divides and spreads its light. Everything upon which its beams did not directly fall, would, in the absence of air, be in black shadow. Thus, one side of a person would be fully illuminated, the other would be invisible. As it is, we have the softest conceivable degrees of shade. Again, if there were no atmosphere, there could be no clouds, and then we should be exposed all day long, and day after day, to the full blaze of the solar heat. To say nothing of the monotonous appearance of every object under such circumstances, the untempered heat would have a very deleterious effect upon our bodies. It must also be remembered that air is essential to the existence of fire, and that without a supply of oxygen gas there could be no flame, and all the forms of caloric would only be perceptible by one of the senses. Without the means of making artificial heat, what would man be?

CROWN GLASS—ITS HISTORY AND MANUFACTURE.

The history of the glass manufacture in past ages affords us a glimpse of the many curiosities of the trading habits of our ancestors, which are amusing enough when compared with those of our own day. At one period, the whole of the artificers employed in glass-blowing were *gentlemen*, many of them of noble descent, and some actually holders or inheritors of noble titles. An old book, "Blancourt on the Art of Glass," the title-page of which runs—"Illustrated with proper Sculptures. London: Printed for *Dan. Brown*, at the *Black Swan*, without *Temple Bar*, MDCXCIX.," gives the names of several glass making noblemen.

The first on the list is Anthony de Brossard, Lord of St. Martin and St. Brice, gentleman to Charles d'Artois, Count of Eu, a prince of the blood royal. De Brossard was himself of royal extraction, being lineally descended from Charles of France, Count of Valois, the son of Philip the Hardy, who succeeded St. Louis to the throne of France. At the time that Blancourt, himself a nobleman, wrote his treatise, the following noblemen pursued the "Art of Glass" in France:—Messieurs de Caqueray, allied by marriage with the family of de Brossard; the families of de Vaillant, de Virgilles, de la Mairie, de Sagrier, and de Bongard, who were all confirmed in their nobility during the search made in 1667, in the reign of "Le Grand Monarque," Louis XIV. It was during the reign of this monarch that an establishment for the manufacture of blown Venetian mirrors and coach-glasses was first set on foot at Cherbourg, under the auspices of the celebrated minister, Colbert.

In these days, the workshops in which window glass was made were termed "the great glass-houses;" and those in which "coach-glasses, drinking-glasses, crystals, cups, bottles, and such like sorts of vessels," were made, received the name of "the little glass-houses," the artificers employed in each being styled respectively "the gentlemen of the great or little glass-houses." During work, the gentlemen were waited upon by obsequious "gentlemen apprentices," whilst all the rough drudgery was handed over to a corps of servitors, who were not unfrequently serfs or slaves. These trade customs were not confined to France, but were common to Italy, Germany, and England; but we have chosen our examples from France, for the reason that the early history of the trade in that country is the best known, and the art of making window glass, although originating at Venice, was earliest brought to perfection in the former country.

When the art was imported into England in 1557, it was carried on in Crutched Friars, London, and the gentlemen of the great glass-houses here established their peculiar customs, some of which were previously practised by the English. In 1635, we find Sir Robert Mansell obtaining a patent or monopoly for the use of pit coal in the place of wood, this application being esteemed a novelty at that period, although in the time of Agricola (1494 to 1555), coal was the only fuel employed for the purpose. Several renowned names are connected with the glass manufacture of this time, for in 1670, the Duke of Buckingham carried into effect at Lambeth what the French minister, Colbert, had previously done at Cherbourg.

In the present iron age, the glass-blowers cannot pique themselves upon any distinctive peculiarities; but the traditions of olden times are carefully preserved amongst them, and some of the oldest hands can remember the last of the "gentlemen." About fifty or sixty years ago, died Joshua Henzell, of Wearmouth Glass-works, who was reputed the last of his race. The old gentleman was warmly attached to the early practices of his craft, and firmly opposed all the modern innovations of his day. As an example of the dignity with which he considered himself to be invested, it is related that, at each operation of "carrying off," the lad who took the "punty" from him, at the same time handed him his walking stick, so that he might walk back with all due gravity and state, a distance of about a dozen yards, to receive a fresh piece of glass for manipulation. When his dinner was brought to him at the glass-house, a *whole joint* was furnished forth for the repast, a table being methodically set out for him alone, whilst his apprentice was posted behind his chair to wait upon him. After he had finished, the fragments that remained were despatched home for the family dinner. Such is a picture of one of the old school of glass-blowers, by an observer.

By way of a record of the state of the glass manufacture about two hundred years ago, we have engraved two of Blancourt's "copperplate sculptures," as illustrations to the present article. We give his own description of the figures:—

"Fig. 1 is the interior of 'a little glass-house,' with the gentlemen at work. The oven, whose diameter ought to be always proportional to the height, is divided into three parts, each of the three parts being vaulted. That below A, is the place where the servant flings in the wood, to keep a continual fire without smoke, and this lower oven is called the crown, and the mouth, and the *Bocca;* but there is neither grates nor ash-hole, the wood being cast in on the coals, care being taken to take them out, when they are too many, with a great iron hollow shovel." Through several apertures in the roof of this lower division, the flames and heat ascend into the "second oven, where are placed the pots filled with the ingredients that make the glass, upon which the flame continually reverberates." One of the pots is shown at E. "The second part of this oven, marked B, whereof the vault is round, serves for the workmen; between each arch there is an opening or hole, made in fashion of a window, archwise, marked C, called the great work hole; these great holes are stopped each with a cover, in the middle of which is a hole somewhat more than a palm wide, which is called the little working hole, and through which the 'metal' (or melted glass) is 'gathered' on the blow-pipes. The upper vault of this furnace, marked D, which is above that where the metal is melted, serves to put the vessels that are new made upon, there to cool by degrees, that place having only a moderate heat, otherwise the vessels would break if they were too soon exposed to the cold air." The author states that only one race of masons in all France, who come from Caule, in the county of Eu, can build the

furnaces of the great glass-houses, "which must have three degrees more of heat than the little glass-houses, and one inch difference in the arch and body of the oven is enough to spoil the whole process." The furnaces were built of brick, and lined with a fire-clay found at Beliere, near Forges.

Fig. 2 represents several of the tools employed at that time. The following is Blancourt's description of "the names of the principal instruments that are used in this art:"—

"The hollow pipe, marked A, serves to blow the glass; it ought to be of iron, with a little wooden handle on the top.

"The rod, marked B, ought to be of iron, but not hollow; this serves to take up the glass after it is blown and cut off the former, so that there remains nothing to do to it but perfect it.

"The scissors, marked C, are those which serve to cut the glass when it comes off the first hollow iron, when it is given to the master workman.

"The shears, marked D, serve to cut and shape the great glasses, as also the lesser, to open them and make them more capacious.

"The instruments, marked E. serve to finish the work, which the Italians call *Pontiglo*, *Passayo*, *Procello*, *Spici*, and also *Lorsello*, whereof we want the figure.

"The great ladle, marked F, is of iron, the end of the handle being only done over with wood; it is with this you take out the metal of the great pot.

"The little ladle, marked G, is also of iron, and covered with wood at the handle; this serves for skimming the metal, and taking off the *alkalie salt*, which swims at the top, as also to take the metal out of the pots, and cast it into water to refine it.

Fig. 1.

"The great and little shovels or peels, marked H, serve only to take up the great glass.

"The less is called the little shovel, and they make use of one like this to draw out the coals and ashes of the furnace where the fire is made.

"The hooked fork, marked I, serves to stir the matter in the pots.

"The rake, marked K, is also of iron, and the handle of wood; it serves to stir the matter, as also to move about the fritt in the first oven.

"The instrument marked L is for making chamber-pots.

"The fork, marked M, is made also of iron, and the handle of wood; there are of them several bignesses, they serve to carry the glass works into the upper oven to cool them.

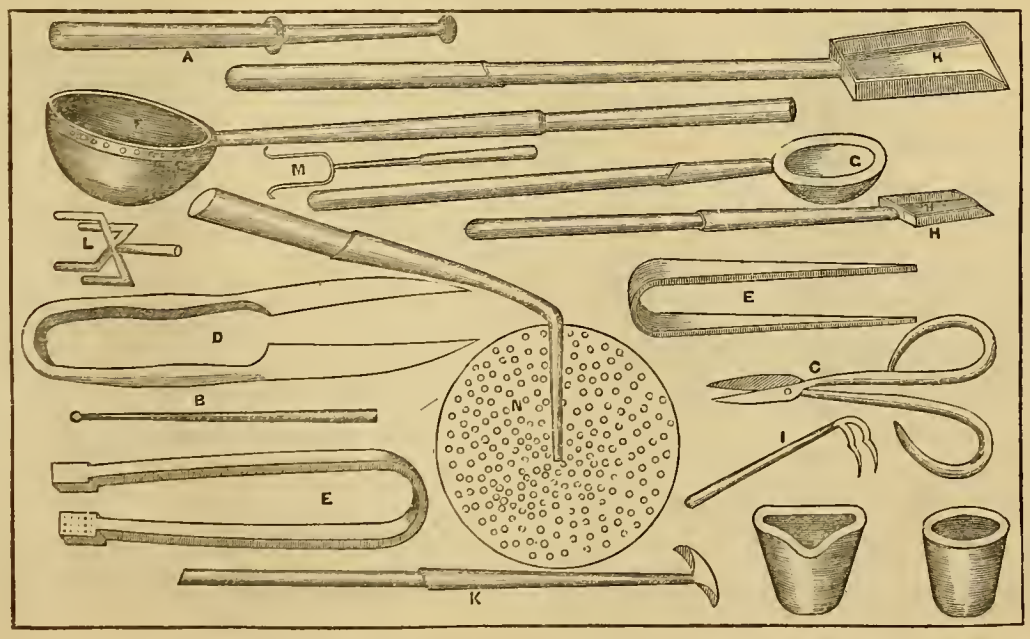
"The great ladle, marked N, is of brass, full of holes about the bigness of a pea; this ladle serves to take off the *alkalic salt* from the kettles as fast as the lee evaporates [*i.e.* in refining the flux.]

"There are also several moulds, both of marble and brass, and also copper, but which would be too tedious here to describe."

The great resemblance which these tools bear to those used now, is very remarkable, and the author's account of their mode of working might almost be taken as a description of the modern process. To those curious on the subject, Blancourt's description is well worthy of perusal.

"The metal in the pots being ready for work, ought to stick, or be clammy, like glutinous, viscous matter; then the workman takes out as much as he has occasion for, with his hollow iron (which sticks to it as he turns it about in the pot); this he rolls to and fro on a marble, the better and more firmly to unite the parts thereof; then he blows gently into his hollow iron, which raises the metal, just as blowing does a blad-

Fig. 2.



der; but when he takes breath in the intervals of blowing, as he must do often when the vessel is large, he must take care first to take the iron out of his mouth, for fear of drawing in the heat, and apply it to his cheek. After which, he takes the iron and whirls it several times about his head, which lengthens and cools the glass, and, if it be needful, he flats the bottom (by pressing it on the marble); then he gives it to the master workman, who gently breaks the collet, or that part of the glass which cleaves to the blowing-iron, and casts it by among the common glass. Then he takes up this glass, by sticking it on another iron rod, to heat or scald it at the mouth of the working hole; then with his *pontiglo* he makes it into glass, and with his *passago* makes the bowl of the glass; and then with his *procello* he widens it, and makes it more hollow and capacious. Then making it plain and even with the shears, he cuts off what is superfluous; and thus with blowing, pressing, scalding, amplifying, and cutting, he forms it into what shape he pleases, putting or fastening on feet when need requires, and with the *spici* puts on rigarines and marblings. After that, a servant takes them with an iron fork, and puts them into the superior oven, marked D (fig. 1), to anneal them. If he does not take especial care, he will break the glass, instead of annealing them, this ware being extremely brittle."

So also in the manufacture of crown or window glass, Blancourt's account of the practices two hundred years ago sounds so strangely familiar to a modern glassmaker, as to render it a difficult matter to believe that it is not a quaintly told description of the modern process. We subjoin the description referred to, and this will end our borrowings from the "Art of Glass," a book we would strongly recommend all glassmakers, who are interested in the history of their beautiful art, to read:—

"This work passes through three hands—the first through the hands of gentlemen apprentices, who gather the matter with their hollow iron that is in the pots in the little working holes, when it is fit to be used or worked, and that till three heats; then he puts it on a marble. Then a

Fig. 3.

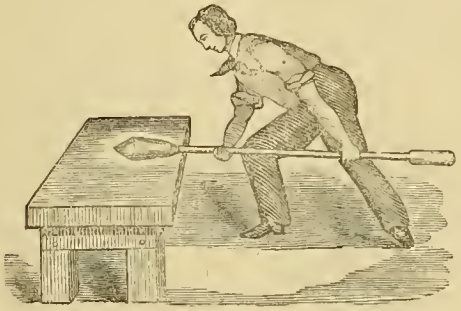


Fig. 4.

second workman, more advanced in the art, takes the iron and gives it yet three heats more, and setting it on the marble, makes it into a lump. Then the master workman takes it and makes it perfect by blowing it, and making it ready to be worked; then there comes a servant with a sharp tool of wood, which he thrusts into the end of the lump or mass, and the master workman, with an almost inconceivable address and art, works it at the heat of the mouth of the great working hole; then casts the plate upon a place prepared on the ground with live coals, to give time to a servant of the glass-house to take it and carry it to a furnace, which is at some distance from the body of the oven, whence you take it out again when it is cold. And it is of these plates they make window glass for the glaziers."

The modern glass-blower having gathered a sufficient quantity of "metal," by several dips of his blowpipe into the "pot" in the furnace, rolls the gathered mass to and fro on a polished iron plate, the "marver," as represented in figs. 3 and 4. The embryo plate is thus made to assume the shape of fig. 5, and being again held nearly in the position of fig. 4, a boy blows gently down the pipe, and swells out the "piece" to the contour of the section, fig. 6. At this stage it becomes necessary to reheat it, the services of a superior workman being put in requisition for blowing it into the shape of fig. 7, the nob, *a*, being the remains of the point or apex of figs. 5 and 6, and which subsequently forms the bullion. Another heat is now taken, and the capacity of the piece is very considerably increased by further blowing, whilst the nob or bullion is held in an iron socket by a boy, as shown in fig. 8, in order to prevent its too sudden expansion.

Fig. 5.

Fig. 6.

Fig. 7.

Two more heats and blowings increase the size of the globe, and bring it somewhat near the shape of the section, fig. 9, when it is spun round in the furnace without further blowing, and, by its centrifugal force, acquires the form of section fig. 10, the equator or "bulge," *b b*, of the piece expanding, and the thin pole or bullion, *c*, becoming flattened, whilst the opposite pole retains its shape from its greater strength and lower temperature. The end of the "punty," or iron rod, *f*, is then dipped in melted glass for the purpose of attaching it to the bullion, *c*, when a drop of water is applied at *d*, and the mass is broken from the pipe by a slight blow of a mallet. The punty now forms the support of the piece, which is again heated at the neck, *d*, by being passed through a small round aperture in the side of the furnace. It is then transferred to the "flashing" furnace, fig. 11, where, as it softens by the heat, a gradually increasing rotatory motion is given to it, and the small opening at the centre enlarges, and finally turns out like a lip, as at fig. 12, which represents the primary portion of the flashing process. The lip continues increasing in width, and the hole extending in diameter, until near the end of the operation, when it assumes the shape of fig. 13. A continuation of this action at length produces the flat circular "table," fig. 14, and concludes the glass-blower's labours. The table is now cut off the punty by shears, and is piled in the annealing oven to cool gradually. When the annealing is completed, the disc, or table, is split across by a straight cut with a diamond, an inch or two from the centre, so as to be out of the way of the bullion, and the two halves are then ready for packing in crates for the market.

Fig. 8.

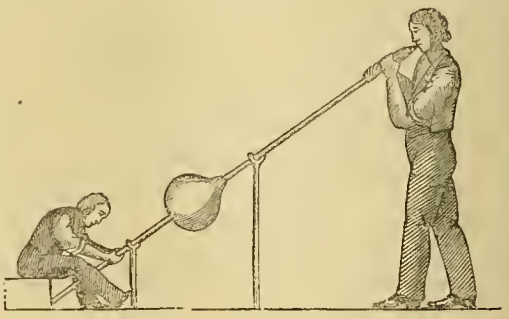


Fig. 9.

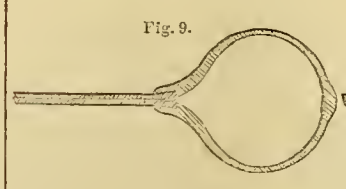
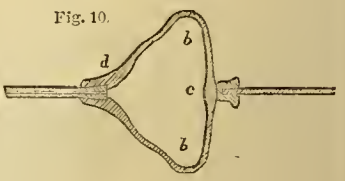


Fig. 10.



This detail closely resembles Blancourt's quaint history, and the general outlines of the whole performance, like the potter's wheel of the earthenware maker, retain principles of great antiquity. The improvements introduced since the time of our historian have chiefly

Fig. 11.

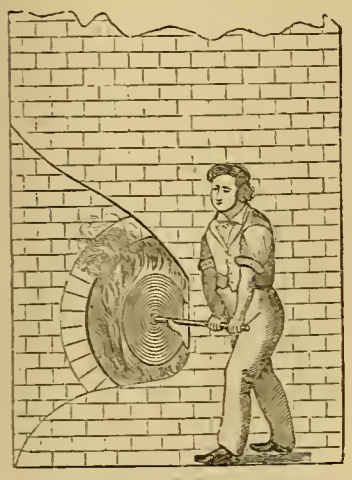


Fig. 12.

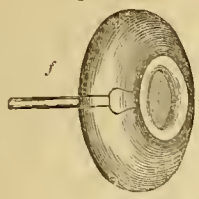


Fig. 13.

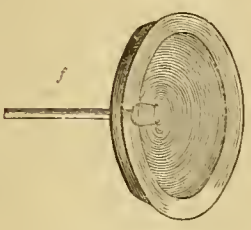
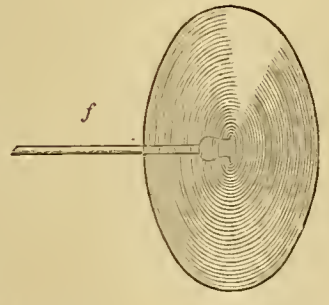


Fig. 14.



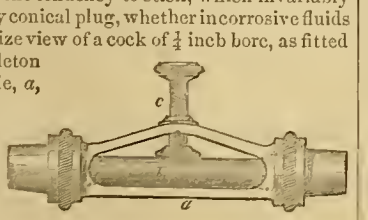
resulted from a close attention to minor details, and the gradual accumulation of minute experiences. The value of these improvements is best explained by comparing the production of a modern glass-house with that of similar houses two centuries ago. The present rate of production averages about 1600 or 1800 "tables" of glass, 51 inches in diameter, and 12 lbs. weight, per week; whilst the "gentlemen of the great glass-houses" rarely perfected more than from 200 to 300 tables of 36 inches in diameter, and weighing 4 or 5 lbs. only; or, in other terms, modern blowers make *eighteen* times as much glass as their gentlemen ancestors.

Although the present age has brought with it so many rivals to crown glass, yet this branch still holds its place in the commercial catalogue. Its peculiar manipulatory processes permit of its completion without coming into contact with any substance likely to injure its surface; sheet glass, on the contrary, is rubbed flat on a stone, and, in spite of all precautions, its surface is indented by minute particles of dust and foreign matter, so that a *reflection* from it is somewhat like the reflection from beaten tin, whilst the reflection from crown glass resembles that from large waves of smoothly undulating water. Again, objects are seen through sheet glass with much less distortion than through crown glass, and squares of the former are to be had of a size considerably greater and much stronger than those of the latter. Thus each kind finds its own purchasers; they who want large squares to look *through*, select sheet glass, and when this species is ground and polished, it forms patent plate, rivalling the old plate glass in appearance, at one-third less cost.

D.

STOP-COCK FOR CORROSIVE FLUIDS.

Mr. Robb, of the Haddington Gas Works, has recently introduced a valuable improvement in stop-cocks for corrosive and other fluids. The chief aim of the inventor was to obviate the tendency to stick, which invariably attends the working of the ordinary conical plug, whether in corrosive fluids or not. Our cut represents a half-size view of a cock of ¾ inch bore, as fitted upon a line of tubing: *a*, is the skeleton frame of the cock; the lower side, *a*, forming a bed or support for a vulcanized India-rubber tube, *b*, the ends of which are drawn over the external screws of the couplings, where the skeleton frame is connected to the tubes. The internal



threads of the ends of the piece, *a*, being screwed upon the former, over the flexible tube, the latter is firmly held between the two, as it shrinks into the interstices of the threads. In this way, the flexible tube forms a portion of the thoroughfare for the fluid or gas, so that there is no working of metal surfaces in it.

A slight bridge of metal, forming part of the skeleton frame, stands above the centre of the tube, *b*, and serves as a support for the small thumb screw, *c*, which passes through its centre, and stands immediately over the tube. As represented in our figure, the cock is full open, the compressing button at the lower end of the screw, *c*, being simply in contact, but not pressing upon the upper side of the tube. It is easy to see how, by turning this screw, the tube may be compressed more or less upon its bearing, *a*, so as to partially or entirely close it up, by bringing its sides together. The compressing button is of considerable diameter, and is well rounded on its lower surface, to prevent any injurious effects upon the tube; and all chafing is prevented by fitting the button upon a small stud pivot, working loosely in the end of the screw, so that there is actually no friction between the tube and its compressor. This arrangement admits of the minutest possible variations in the opening through the tube; but if it is intended for quick closing, an eccentric or lever may be substituted for the screw.

Where it is of importance to secure the liquid or gas from contact with the metal of the cock, the tube may be lined throughout with the flexible material, and the couplings will not be required.

The chemist will recognize the value of this stop-cock for numberless purposes, more particularly for testing apparatus—Marsh's arsenic test, for instance, as improved upon by the scientific committee of the Prussian Government, and for the transmission of gases through tubes in a state of dryness.

ON THE RATIONALE OF THE EXPLOSION CAUSING THE GREAT FIRE AT NEW YORK, IN 1845.

(Communicated to the Franklin Institute.)

Dr. Hare communicated to the meeting some inferences and facts, tending to explain the contradictory impressions which have existed respecting the competency of fused nitre to explode with water, or with aqueous, hydrogenous, and carbonaceous combustibles. This subject was treated of in reference to a series of detonations terminating in an explosion of tremendous force, by which, in July, 1845, the intensely ignited contents of a store, in Broad Street, New York, were thrown over an extensive district, involving the destruction of about 200 houses, and property, estimated at two millions of dollars. As far as the oaths of highly competent witnesses could avail, no gunpowder was present; so that the result could only be attributed to the reaction between an enormous quantity of nitre and combustible merchandise with which the store was promiscuously occupied. In all, there were three hundred thousand pounds of nitre in parcels of 180 lbs. (each secured by two bags, an additional bag having been put over that originally employed.) About 180,000 lbs. was situated upon the second floor, 50,000 on the first floor, and 80,000 on the third floor.

Of the merchandise, the aggregate was more than double the weight of the nitre.

It was, however, the general opinion of those best acquainted with the subject, that, when ignited with combustibles, nitre produces only that species of combustion which is called deflagration by chemists, without being capable of the more violent and instantaneous reaction designated by the word explosion. This impression was strengthened by the failure of every effort (made by several eminent chemists employed by the corporation of New York) to explode nitre by ignition with combustibles.

Nevertheless, agreeably to Hays, of Massachusetts, an explosion was effected in his laboratory, by bringing water into contact with about 100 lbs. of incandescent nitre; also, the accidental falling of a jet of melted nitre on some water, in the laboratory of the University of Pennsylvania, had been productive of a similar result.

The explosion of a vessel ladened with nitre, which, while lying in Boston harbour, was burnt to the water's edge, and of others similarly ladened and burnt, could only be explained by supposing that nitre, when sufficiently heated, will explode with water on due contact. Consistently, it might be inferred that this salt (well known to be a compound of nitric acid and oxide of potassium or potash) would explode with any substance capable of yielding either or both of the elements of water or hydrogen. The presence of the latter would be equivalent to water, since it would, with the oxygen of the acid, form water.

In a letter, addressed to the distinguished chemist above mentioned, in July, 1845, Dr. Hare had adverted to the explosion which succeeds

the combustion of potassium upon water, as arising from the combination of one portion of the water with the resulting incandescent globule of oxide, while the heat of this globule, uniting with another portion of the liquid, converts it into high steam. Moreover, it was suggested that, in this instance, chemical affinity between the water and the oxide, in causing the water and heated globule to coalesce, is equivalent in efficacy to the momentum of the hammer when a bar of iron, at a welding heat, is forced into contact with some moisture situated upon an anvil.

Dr. Hare presumes that no explosion can take place unless the reagents for producing it are held or brought together, at the moment of reaction, by a certain force, either chemical or mechanical.

Some chemical compounds, such as are formed with fulminic acid, or with ammonia, by metallic oxides, also the chloride of nitrogen and perchloric ether, explode violently without confinement, so as to fracture a plate or saucer, upon which a small quantity may be detonated; but pulverulent mixtures, such as gunpowder, however powerfully explosive when employed in gunnery or rock-blasting, in open vessels flash without fracturing them, or producing any report. In an exhausted receiver, gunpowder is far less explosive than when subjected to atmospheric pressure in an open vessel. Nevertheless, when gunpowder is restrained until the temperature requisite for the appropriate reaction of its ingredients is attained, it exerts a force far exceeding that of the chamber confining it. In this respect it differs from steam, of which, when the temperature of the fire applied is sufficiently high, the explosive force is directly as the pressure before bursting, and this, of course, is commensurate with the strength of the confining boiler.

The ingredients of gunpowder, sulphur, charcoal, and nitre, to produce the greatest effect, require extreme comminution and intimate intermixture by trituration, and to be so granulated, that the flame of the portion first ignited may convey inflammation to the rest through the interstices between the grains. Its superiority over any other mixture of nitre with combustible matter destitute of sulphur, is conceived to be due not only to the pre-eminent susceptibility of this substance, of vaporization and inflammation, but likewise to its well-known ability to decompose metallic oxides by attracting both the metal and oxygen. Since an opinion was expressed in 1845, in the letter above mentioned to Hays, that the formation of sulphide of potassium is the first step in the process of the explosive reaction of gunpowder, Faraday has alleged the flame of this compound to be, in the case in point, an important instrument in the propagation of fire throughout the mass.

The hepatic odour of the fumes consequent to the firing of cannon, and likewise of the washings of a gun after the customary service, demonstrate the production of a sulphide. It has been found that a filtered solution of the residue displays, when tested by iron, the red hue which indicates the presence of a sulphocyanide.

Agreeably, however, to a qualitative examination, the solid residue of exploded gunpowder consists mainly of nearly equal parts of carbonate and sulphate of potash, while the gaseous residue is constituted nearly of equal volumes of carbonic acid and nitrogen. Of course, the sulphate may arise from the oxidation of sulphide formed at the outset. Notwithstanding that the ingredients of gunpowder are prepared as above stated, confinement is necessary to prevent the grains from being thrown apart and chilled, so as to prevent the propagation of the ignition, through the congeries forming a charge, by means of the flame of the first portions fired. This was fully demonstrated by the exposure of a pile of gunpowder, comprising enough for the charge of a musket, within an exhausted receiver, to a wire intensely ignited by a galvanic discharge. The grains did not take fire instantly, probably because the vapour evolved prevented actual contact; and when ignition did ensue it, extended only to the production of a feeble flash. On examination, it was found that a portion of the powder had escaped inflammation.

In the next place, a like weight of gunpowder was consolidated into a cylinder by intense pressure. Thus prepared and ignited, by contact with an incandescent wire in the exhausted receiver, more than half of the cylinder remained unconsumed.

A much larger cylinder of the same mixture, similarly consolidated, placed at the bottom of an iron pot, four inches in diameter and twelve inches in depth, on being touched by the end of an iron rod reddened in the fire, burnt at first like a squib, but towards the last was dissipated with an activity in some degree explosive, probably in consequence of the pressure created by the reaction of the gaseous current generated by its own deflagration.

The want of confinement, which is thus capable of lessening the explosiveness of gunpowder, of which the constituents are intimately intermingled, is still more enfeebling where analogous reagents are ignited together without admixture or comminution. Under these circumstances, the reageuts are made to recede from each other by the generation of that vapour or gas, to the evolution of which, under confinement, the capability of exploding is due. Thus sundered, they are chilled by radiation, so that the temperature requisite to sustain and communicate ignition is not supported. Moreover, the rapidity of reaction being as the multiplication of the points of contact, and these being fewer as the substances are less divided and intermingled, the deflagration takes place in detail, instead of having that simultaneousness which is indispensable to render it explosive.

In addition to the ideas above mentioned, as having been conveyed in Dr. Hare's letter to Hays, it was urged also, that his inference as to the explosion of water with incandescent nitre, being attributable to a reaction analogous to that represented as taking place when potassium is burnt with the oxide of potassium, was supported by the fact, that at a white heat, the base of nitre spontaneously abandons its acid, while from water it cannot be separated by any temperature. Consequently, the presentation of substances, consisting of carbon, hydrogen, and oxygen, by yielding water to the base, could not but be productive of a result analogous to that which results from the presentation of sulphur and carbon.

The only obstacle is as follows:—Substances containing hydrogen and oxygen, whether in the proportion for forming water, like sugar, starch, gum, and wood; or having an excess of hydrogen, like oils and resins; moreover, all the constituents of nitre, even the base, are susceptible of the aeriform state at the temperature producible by the reaction of nitre with them. But when kept together until that point is attained, the explosive power must be fully equivalent to that of gunpowder. The reagents are in a state analogous to that of two gases extremely condensed.

The explosibility of incandescent nitre with water was illustrated in the small way, by heating a portion in a platina capsule by the flame of a hydro-oxygen blowpipe, and sudden immersion in the liquid. So active was the explosion, that a portion of the resulting hydrate flew out upon the operator. Yet, when thrown in the same state upon molasses or sugar, no explosion ensued: nevertheless, when a capsule, containing nitre heated to the point of volatilization, was struck with the face of a hammer, coated with sugar melted upon it, and made to adhere by moisture, a detonation took place. A still more powerful detonation was produced as follows:—

Upon an anvil, a disk of paper, of three inches in diameter, was laid, covered with pulverized sugar. Over the sugar was placed another similar disk, covered with pulverized nitre. A bar of iron, rather wider than the disks at a welding heat, was then held over them, and subjected to a blow from a sledge. An explosion, with a report like that of a cannon, ensued.

Instructed by the facts and considerations above stated, it is inferred that the explosions which contributed to extend the conflagration in New York, as above mentioned, arose from the reaction of the nitre with the combustible merchandise with which it was surrounded. It is presumed, that as soon as the fire reached any of the gunny bags, it must have run rapidly through the whole pile, by means of the interstices necessarily existing between them, the nitre with which they were embued causing them to deflagrate. Much of the salt being thus brought to the temperature of fusion, it must have run about the floor, reached the combustibles, and soon found its way to the next story through the scuttles which were open. All the floors must have been rapidly destroyed by the consequent deflagration, far exceeding in activity any ordinary combustion. Meanwhile the nitre being all liquefied and collected in the cellar in a state of incandescence, and the merchandise conglomerated by the fusion of sugar and shell lac, aided by the molasses, the weight, the liquidity, and temperature must have produced all the conditions requisite to intense detonations. The floors having been consumed, the store must have been equivalent to an enormous crucible of twenty feet by ninety, at the bottom of which were nearly three hundred thousand pounds of nitre, superficially heated far above the temperature producible by any furnace, so as to convert the reagents into nascent aeriform matter under a pressure of half a million of pounds. The intense reaction, however, would not permit of durable contact. At each impact, the whole mass must have been thrown up explosively, and hence the successive detonations. But the chemical reaction, the heat, and the height of the fall, growing with their growth, and strengthening with their strength, the last elevation was succeeded by the thundering report and stupendous explosion, of which it has been an object to afford a satisfactory explanation.*

GUAGE PIPE FOR MEASURING THE FLOW OF WATER.

By M. Lapointe.

The importance of a simple and accurate means of measuring the constant or variable flow of water during any given period, has led many engineers to bestow their attention upon hydraulic experiments, but so

* In a short time a more circumstantial account of Dr. Hare's experiments and inferences, respecting the subjects of the above communication, will be published.

far the subject has hardly yet been properly fathomed. A memoir, bearing upon the matter, has recently been laid before the French Academy of Sciences, by M. Lapointe, and a committee, consisting of Poncelet, Piobert, and Morin, has reported thereon. According to M. Lapointe's experiments, he has attempted to ascertain immediately, and without other measurement than the mere inspection of an index, the quantity of water-flowing through any aperture, and under any circumstances.

The apparatus consists of a cylindrical pipe, furnished with a little wheel with helicoid wings, the axis of which wheel is in a line with that of the pipe, and gives motion to an index placed above the water, within sight of the observer. The pipe is widened at its mouth to a form resembling that of the contracted vein issuing from a circular aperture, and is bolted to the face of a dam, so that all the water to be measured must pass through it. It is placed horizontally, and at such a height that its upper edge shall be always below the level of the water, to ensure a constant full supply. The wheel is placed at such a distance from the mouth of the pipe, that the parallelism of the filaments of water may be established before they reach it. The index is driven by light bevel gearing, connected with the spindle of the wheel, and by its means the number of the wheel's revolutions, in any given time, may be ascertained without stopping or changing its motion. The velocity of the wheel, of course, increases with the expenditure of the water acting upon it, according to a law, the correct application of which was determined by direct experiment. These experiments were carried into effect by M. Lapointe, at Bouchet, in one of the mill-races of the powder works there. The outlet was closed by a gate of planks, in which were three openings, each three-tenths of a metre square,* cased with sheet iron. Discharge gates, adjustable by screws, were provided, so that the proper level of water was constantly maintained. The edges of the openings were sharp, and were similar in arrangement to the opening studied by Poncelet and Lesbros. The guage tube was placed in another dam, at some distance from the former, above which a constant level was established. The levels being thus controlled, it was certain that the guage pipe and the measuring gates discharged equal volumes of water. One observer took charge of the gates, whilst another watched the guage pipe, and registered the number of revolutions of the wheel by means of one of Breguet's counters.

In the first experiments, of which the results are given by M. Lapointe in his memoir, he operated in this manner with constant levels: the differences in the height of water above the dam, and that below it, being comprised between ·06 and ·24 metres. Now, taking for abscissa the volumes of water expended in a second, and for ordinates the corresponding number of revolutions of the wheel, he has shown that all the points thus determined fall upon the same straight line, which intersects the axis of the abscissa in advance of the origin of the co-ordinates. From which he concludes—1. That the movement of the wheel does not commence unless there flows, in a unit of time, a certain volume of water; and 2. That for the different volumes of water discharged in a unit of time, the increase in the number of revolutions of the wheel is proportional to the increase in the volumes expended. The law, therefore, which connects the number of revolutions with the corresponding volumes of water expended in a unit of time, may, when the rule is established, be represented by the simple equation of a right line, $Q = a + bn$; in which Q represents the quantity of water discharged in a second; a and b the constant numbers furnished by the observations, and which, for the wheel used, have the following values: $a = \cdot0635$ cubic metres; $b = \cdot01247$ cubic metres; and n the number of revolutions in a second.

In comparing the results of this practical formula, $Q = \cdot0635$ cubic metres $+ \cdot01247\ n$, with those of the direct observations, it was found that the greatest variation of the result of the formula from that which was furnished by the observations at the gates, was $\frac{1}{40}$ of the latter; and this difference, which is sometimes in excess and sometimes in defect, should be rather attributed to errors of observation at the gates, than to the instrument itself. It was therefore established, by these first experiments, in which the volumes discharged per second varied from ·131 to ·372 cubic metres, that, when the discharging and receiving levels continued constant, the above formula will enable us directly to calculate the expenditure, by knowing the number of revolutions made by the wheel. But as in these experiments the operations were successively conducted at different velocities, it was natural thence to conclude, that the relation between the velocity of the water, or the expenditure, and the number of turns of the wheel, was independent of that velocity; or, that the co-efficients a and b of the formula were independent of the velocity; and that, consequently, this formula ought to apply, with the same accuracy, to the measuring of water when the velocity was variable, as when it was permanent. This last consideration greatly extended the utility of the guage pipe, inasmuch as it rendered easy the measurements under variable levels, and enabled observers to avoid one of the principal causes of error in experiments upon water power. However plausible this conclusion might be, M. Lapointe rightly conceived that it was necessary to verify it by special experiments. For this purpose, and in order at the same time to extend the field of his observations, he obtained from the able engineers who have the direction of the Paris Water-works, authority to fix his apparatus between two of the great basins of Chaillot, the regular form of which is favourable to guaging by direct measurement of the volumes.

A trench of 1·40 metres in width, by 1·80 in depth, was made between the two reservoirs, and extended in the lower basin by a wooden trunk of the same size, and about five metres in length; making the total length of the conduit about nine metres. At the entrance of this conduit is a gate, by means of which the flow of water from the upper to the lower basin may be regulated at pleasure. Below this gate was placed the dam, to which was attached the guage pipe previously employed at Bouchet. A second dam, placed at the outlet of the conduit, allowed the water of the lower level to be kept at a convenient height above the extremity of the pipe. The water which passed over the dam fell into a trough, in which were placed inclined planes to conduct the water down gently, that it might fall into the basin without causing too great an agitation of the surface. A wooden float, so large as to be little affected by the waves on the surface of the water, sliding on a rod graduated to every five centimetres, was used for determining the elevation of the level. The steam pump at Chaillot raises but about 140 litres of water in a second; but, on account of the excess accumulated in the reservoir, much more than this quantity could be used in operating with variable heads of water. At the commencement of a series of experiments, the upper basin was full, and the lower one almost empty; there was then a strong head, and the pipe discharged more than the pump supplied; in consequence of which, the level above the pipe was reduced, as well as that below it; but the former more than the latter. The moving power, therefore, being equal to the difference of the levels, was constantly diminishing, until the pipe discharged but about 140 litres, the flow and the supply being then brought to a permanent condition.

Ingenious arrangements having been made to that effect by the author, the observations of the height of level in the lower basin,—of the corresponding time,—and of the index showing the number of revolutions performed by the wheel,—were all made readily and simultaneously by the same person. In order to account for the difference in the values obtained for the constants of the formula in these experiments, it should be observed, that the wheel and index used, had been altered in their proportions from those used in the first experiment. These new experiments, to the number of 68, made under conditions of movement varied with the heads of water giving the velocity comprised between ·01 and ·435 metres, were graphically represented like the preceding, and in like manner showed that the relation between the volumes of water expended, and the number of revolutions of the wheel, is expressed by the equation of a right line. But here, in consequence of the changes made in the proportions of the wheel and the index, the values of the constant co-efficients of this equation are $a = \cdot024$, and $b = \cdot02203$ cubic metres, which leads to the practical formula for calculating the flow per second, $Q = \cdot024 + \cdot02203\,n$; or, if the observation be continued during a period expressed in seconds by t, then $Q = \cdot024\,t + \cdot02203\,n$, in this case n being the whole number of revolutions during the time t. The discharges observed having been comprised between 77 and 423 litres in a second, it will be perceived that they varied nearly in the ratio of 1 to 5·5. Two of the committee caused several of the experiments to be repeated. These were made indiscriminately with full and medium heads of water, and the results obtained agreed perfectly with those observed by M. Lapointe. Another guage pipe, intended for the discharge of a larger quantity of water, with a diameter of ·70 of a metre, was also tried at the basins of Chaillot. A series of 33 experiments, in which the difference between the upper and lower levels varied from ·03 to ·23 of a metre, and the expenditure from ·8158 to ·2338 cubic metres, verified anew the proportionality of the discharges to the expression of the form $a + bn$. The graphic representation of the results gives for the constants a and b, the values $a = \cdot014$, and $b = \cdot0478$ cubic metres; and consequently, for the practical formula, $Q = \cdot014 + \cdot0478\,n$. The general result of these experiments is, that the guage pipe, wheel, and index of M. Lapointe, furnish a simple, expeditious, and accurate means of determining the quantity of water which passes through the tube, either under constant or variable heads. Its application is not more difficult than that of any other method of measuring by dams, and is not subject to the same uncertainty. When the tare of the instrument has been once carefully established, it will at once give the volume of water desired to be known. The diameter of the pipe being only limited to a size which

* One foot, English.

will admit of being readily placed in the proper position, it will be perceived, that by means of one or two pipes of this kind, streams of water may be measured which deliver several cubic metres per second. Such an apparatus would be of great utility in experiments relative to the employing of water power, in situations where the measurement is attended with many difficulties, and occasionally gives rise to disputes. But whatever care the author may have bestowed upon the determination of the practical formula, by the aid of which the discharge is computed, it is proper that this determination, which consists in what may be called the *tare* of the instrument, might be examined and verified in the presence of the parties interested, if there is a question in dispute; and to this effect the author proposes to study the ratio which connects the number of revolutions with the pressure of the head of water in constant levels, by which he will be able to make this verification.

It was suggested by one of the committee, that a highly useful application of M. Lapointe's apparatus might be made by employing the wheel and index themselves, to limit and regulate the volume of water discharged by the pipe, independent of the time and the variation of level. Thus modified, the apparatus would become a real *water meter*, which would be of important service in the supply and distribution of water to cities; and, above all, in cases where water is to be shared or divided between parties.

On the whole, the committee conclude that the gauge pipe of M. Lapointe is convenient in practice, and that it supplies a quick and sufficiently exact means of measuring the flow of a stream; and therefore propose that it should receive the approbation of the Academy.

THE THEATRES AND PORTICOES OF ANCIENT ROME.

By the Rev. R. Burgess, B.D.

(Concluded from page 102.)

The remains of the theatre of Marcellus are worthy of the architect's admiration. Eleven arches of both orders, and part of a twelfth, are conspicuous, though mutilated and disfigured by the dusky habitations into which they have been metamorphosed. The first order is nearly half interred, but the capitals of the Doric columns, as well as the entablature, are well preserved in several places. The second story exhibits a specimen of the Ionic order, as it was brought to perfection in the age of Augustus. Within those arches which formed the "ambulacra," as in the amphitheatre, the "gradus spectaculorum" rose, and some of the "cunei" may be traced in the stables of the Osteria della Campana. The materials are Tufo, mingled with brickwork, resembling those in Pompey's theatre; and one may perceive, by a solitary column in the Via Savelli, standing at an angle with a piece of wall running in the direction of the scena, that the stage and its outworks must have touched the very banks of the river. The Palazzo Orsini, formerly Savelli, is built upon the ruins of the stage. Piranesi has calculated the capacity of this theatre to contain 25,000 persons; it was therefore the smallest of the three. Julius Cæsar, perhaps, laid the foundation of this edifice, but it was left for Augustus to complete it, and he dedicated it with the name of the Young Marcellus. On the feast of the dedication, it is said that 700 wild beasts from Africa were consumed, and then, for the first time in Rome, there was seen a tamed tiger. We have an account of a fire having partly destroyed this theatre, but we hear very little of its history until Pierleone, in the twelfth century, made it a fortress. It passed successively into the possession of the Savelli and Orsini families, and there is no reason to suppose it has existed otherwise than it now presents itself for several centuries. In Carnucci's Antiquities, we have a drawing of it, bearing date 1565, and it is there exhibited just as we see it at the present time. I may mention that its exterior walls are of travertine stone. The 25,000 spectators are now replaced by some workers in charcoal and some mules, the former occupying the places reserved for the magistrates, and the mules having taken possession of what was the orchestra. Near to the theatre of Marcellus stood the famous portico of Octavia, to which I have finally to call your attention. And although we must penetrate into the filthiest habitations in Rome, among stinking fish, in order to see the remains of this splendid work, it will amply repay us for our excursion, and stamp indelibly upon our memories the flavour of the Pescheria, and the conservative habits of the Jews who live within the portico of Octavia.

The first marble building ever erected at Rome was a portico which stood on this self same-site. It was built by Metellus Macedonicus: two temples were comprised within it. The architects were two Spartans, whose names were Sauros and Batrachus. They not only contributed their skill, but, as they were rich men, they employed their wealth also in the undertaking. The only reward for their services which they asked of the Romans was, that their names might be mentioned in an inscription on the temples; but this honour being refused, they contrived to introduce their names allegorically: Sauros meaning a lizard, and Batrachus a frog—those animals were introduced into the capitals of the columns. The architects of the portico of Octavia were also Spartans, and they respected the works of their distinguished countrymen. The new portico comprised in its circuit the two temples, made more magnificent and probably much enlarged: the fragment of the Pianta Capitolina, with the mutilated inscription "CVS OCTAVIAE," gives us the plan of those splendid works. Bellori, in his illustration, computes about 270 columns. I confess I cannot make out that number with the utmost stretch of my feeble imagination, but I can present you with a plan made on the authority of the fragment and the ruins which still exist, adjusted on the dark tints, which show them in their proper places. By this plan, it will be seen that the principal remains consist in six large columns of the vestibule or entrance (and who that has seen Rome has not admired the magnitude and elegance of those Corinthian columns!) eight more columns of the exterior row of the perystyle, which are only to be seen by contending with the fish-stalls made out of the spoils of the portico; and there are also further remains of one of the temples to be seen in a Vicolo, behind the church of St. Angelo: three columns standing at an angle indicate the position of the prostyle of the temple of Juno, the other was dedicated to Jupiter. I must leave you, gentlemen, to rear from this ground-plan, and from the splendid vestiges which remain, the elevations and architectural views of the portico and its temples; but even your ingenuity would not be able to restore to their proper niches, or affix on their respective walls, the works of art which once adorned the portico of Octavia. In the temple of Juno was her statue, made by Dionysius and Polycles; and a Venus, by Philiscus of Rhodes. In the corresponding temple of Jove was the much-admired statue of the god, which was equally well executed by those sons of Timarchus. There was a group representing Pan and Olympus wrestling together, the work of Heliodorus; and perhaps the Venus of exquisite beauty which Pliny tells us adorned this portico (the work of Phidias) may be the very Venus de Medici which Santo Bartoli declares was found here in the Pescheria. In a part of the building called the Schola Octaviæ, was the famous Cupid of Praxiteles, which called forth the eulogia of Cicero, Strabo, and Pausanias. It is more than probable that several of those statues perished in the fire which took place in the reign of Titus, and still more might be lost in that which happened under Sep. Severus. The paintings which adorned the walls and vaults were not less celebrated. There was the famous work of Artemon, representing Hercules ascending from Mount Oeta to Olympus, having put off his mortality with the consent of the gods; there was the painting by Antiphilus, where four figures of satyrs were grouped around the noble Hesion; and Alexander and Philip, with Minerva. You may exhibit to us an elevation restored; a few columns will direct you to complete the portico, and a medal will give you a finish for the pediment. You may square us off the basements, and crown the balustrade with colossal statues and urns; and you may festoon or tryglyph the entablature; but you cannot paint afresh the works of Artemon and Antiphilus, nor mould again the forms which the innate flash of the mind of a Phidias or a Praxiteles could produce. You must, therefore, be content with the bare recital, and inscribe upon the very best edifice I can describe, "*Stat nominis umbra.*" But you will remark, in the enumeration of the names of those celebrated artists, that they were all foreigners; and Rome owed her most splendid works of art, I may say all of them, to the Greeks, and they owed much of their theatrical amusements to the Syrians and Egyptians. It is, in fact, a mistake to attempt to nationalize either art or science. If there be such a thing as communism in the world, it exists in the realms of genius, and no petty jealousy should ever attempt to exclude the foreigner who brings his originality of thought and genius to adorn a country of which he is not a native. It was written over the tomb of Ludlow, in Switzerland, "*Omne solum fortipatria,*" and the same may be said of the man of true genius, he belongs to every country; and I should say, it generally betrays a sense of inferiority wherever there is an attempt to exclude from fair competition the genius which comes from a foreign shore. The Romans did not this, even in the histrionic art; they excelled in gladiators, but they were inferior in sculpture, and painting, and architecture: by admitting foreigners, they ended by taking the lead in architecture at least, and perhaps the studio of Emilius might have furnished a work worthy of the best Greek sculptor. And let me remark, that there are some things which no patriotism or spirit of nationality will accomplish. It will never make a man of taste admire an ordinary painting or an ungraceful statue; it will never reconcile him to a meagre elevation or an ill-designed public building.

I have generally attempted, in my papers which I have had the honour to read at the Institute, to show the influence which the public institutions under consideration might have upon the character and destiny of

the Romans; and perhaps there is much more connection than at first sight appears between the works of the architect and the national character of a people. The architect is called upon to create only those works which are suitable to the habits of the people, and his object should be to study to do these well; and I, for one, do not regret that he is now compelled to study the construction of churches and schools rather than that of theatres and porticoes. I am more than satisfied with the unarchitectural erections of Covent Garden and Drury-lane for theatres, and for porticoes and groves Vauxhall and the Surrey Zoological.

I am still compelled to speak only of the comparative innocence of our places of public resort; they are immeasurably inferior in architectural beauty, but they are a great improvement upon the moral aspect, and the restraints and the reflective influence of Christianity have even reached our public amusements. We cannot wonder at the indignation with which the early Christian writers viewed the theatres and places of public entertainment among the Romans, where every brutal passion or lascivious desire was gratified, and where vice, in every form was enthroned by universal suffrage. We can excuse these holy men applying to these rendezvous of iniquity the title of "Devil's houses," for which I would hope no member of this Institute will ever have to give a plan. It is to my mind a happy circumstance that the "cavea" is now transferred to the lecture room, the orchestra transformed into an Exeter-hall platform, the stage to the floor of the House of Commons, where sometimes members offer to die, and the pulpitum to the place from which the people are instructed in the truths and duties of Christianity. You will excuse me, then, if I rather rejoice over the ground you have lost in modern times for the exercise of your beautiful art; and that *my* profession has so amply supplied, by the sacred edifice, the field that is gone from you in the profane. I rejoice, not because either you or I have a stage more or less for our exertion, but because I think that the best interests of mankind and the happiness of the human race are more likely to be promoted by a church than by a theatre; and if we compare the national tastes of two neighbouring and rival countries in this respect, we at lest shall be satisfied with the results;—and although I am loath to end this paper with a sentiment that may sound harsh to some, I cannot but be of opinion, that as the influence of Christianity prevails, and sober-minded pursuits follow as a matter of course in its train, theatrical representations, except for children, will give place: meanwhile, whatever tends to purify our places of public resort, and make them really places of recreation, is a benefit conferred upon the morals of the rising generation.

AGRICULTURAL MECHANICS.—HIGHLAND AND AGRICULTURAL SOCIETY'S EXHIBITION AT EDINBURGH—ROYAL AGRICULTURAL SOCIETY'S EXHIBITION AT YORK.

The science of agricultural mechanics is rapidly moving forward to its true position, and the many effective steps lately achieved by it, promise fair to place the farmer's pursuits in the same rank with other avocations which philosophical principles have not merely assisted, but primarily formed. The exhibition of implements of the Highland and Agricultural Society of Scotland, at which we were present, on the 2d of August last, has afforded us ample evidence of this progress. The Society having notified that no exhibition will take place in 1849, every exertion was made by inventors and improvers in all parts of the kingdom, to bring forward a good show of productions.

The exhibition ground was in the Dean Park, about a quarter of a mile from Dean Bridge, where about ten acres were enclosed by a substantial timber fence. From amongst such a collection of implements, it would be a difficult task to particularize all those worthy of notice. Ploughs were in great abundance, and the committee put their promised qualifications to a hasty proof in an adjoining field. Amongst the number are to be mentioned three, constructed by Messrs. Robert Gray and Sons, of Uddingston, Glasgow, with some judicious improvements in the general framework, without joints and mortices. One of J. Wilkie and Co.'s, of the same place, a two-horse swing plough, joints and mortices dispensed with. Two of Gray and Greenshields', Stane, Shotts Iron-works, Whitburn. Two made by W. and R. Mushet, Dalkeith Foundry, one for deep solid ploughing, with an improved mould board. Two of Robert Crawford's, of Uddingston, were highly admired. One of George Ponton's, of Grongfoot, a double mould board plough, for cutting and raising a large quantity of furrow. Mr. J. Cunningham, Edinburgh, had one, classed under the general head of useful inventions. This was a light skeleton plough, with diminished surface, intended to lessen the draught. The coulter is arranged to turn in a round box, so that it may be adjusted to any angle; and a moveable plate is attached on one side, to render it serviceable as a hulking plough for drills. A tilling plough, by Andrew Coltman, Athelstaneford, Haddington, improved to expose the greatest possible surface.

Crosskill's one-horse Scotch cart excited a good deal of attention. It is very light, and on springs; very unlike anything of the kind in this district, and quite opposed in its general construction to the notions of Scottish agriculturists. It is, to our mind, an excellent article, but it may be questioned whether its extreme lightness would allow of the hard usage such conveyances meet with. The wheels were very good, and it is said to be almost wholly produced by steam machinery. A one-horse spring cart, with waterproof covering, by the same maker, is a convenient thing for a farm. Young, of Monefieth, Dundee, and Law, of Shettleston, produced capital strong farm-carts; the latter is perhaps to be preferred for the better disposition and attachment of the body to the axle.

In thrashing and dressing machines, Mr. David Craig, of Stewarton, Ayr, had an immense specimen, most complete in all its movements, having a vibrating riddle placed beneath the shakers for riddling out the straw and black tick, delivering the corn into elevators, by which it is carried to double blast fanners, and thence run into bags. J. Wightman, of Ballymiglaff, Comber, Ireland, had two good double blast fanners for cleaning and dressing grain and seeds. Messrs. Richmond and Chandler, of Salford, showed some first-rate linseed crushing machines. Messrs. Richard Garrett, of Leiston Works, Saxmundham, had a set of beautiful models of drills, of which there was a large collection. Garrett's horse hoes for fine ground elicited the good opinion of most of the viewers; the work is said to be done by them for 1s. an acre. A turnip-cutter, by whom made we forget, attracted our attention from its ingenuity. A series of cutting-knives are fixed horizontally, with their cutting edges uppermost, and at each stroke of the machine, a crank and lever brings a scoop of turnips forward, emptying them upon the cutters, the cutting action being obtained by a wooden stamper, which presses on the vegetables when lying on the cutters.

The drain and general tile-making machinery formed the chief spectacle in the field. Mr. Alexander Cairns, of Denny, Stirling, had an excellent drain-pipe machine, with a simple and clever shifting lid for the clay chamber. A clay mill, and grater for cleansing the clay from stones, made by G. West, Riccarton, Linlithgow, possesses many ingenious features.

Mr. John Whitehead, of Preston, Lancashire, had a capital machine for making any kind of tile. The box contains $1\frac{3}{4}$ cwt. of clay, sufficient to put out 55 two-inch tiles. It is fitted with a screen plate for clearing away stones. This is the machine which gained the prize at the York exhibition last month. Mr. John Young, of Ayr, exhibited a registered machine of novel construction. The clay is rolled out at the back part of the machine, and is thence passed between a graduated series of inclined rollers, which form it into a tube, just like bending a sheet of metal to a tubular form. Messrs. Garrett had a pipe-tile machine, invented by Richard Weller, Capel, Dorking. It has two D-shaped clay cylinders, worked alternately by a lever purchase, the tiles being forced out in rows of three or four. The sets of steaming apparatus, made by Richard Robinson, of Belfast, are useful for the preparation of food for cattle. The boilers are fitted with the "window" water gnage (engraved at page 43 of our May number), by which the water level is accurately and easily ascertained. The iron uprights or ballusters of Captain Sitwell, Dunmore Park, are good, being easily removed, and requiring no stone pedi-ments.

The Archimedian root-washer of Messrs. Crosskill is simple, and well adapted for its purpose. By simply reversing the handle of the horizontal washing cylinder, the roots are screwed out by the interior helical framework. Mr. Slight exhibited the rotatory screw pump of Mr. M'Dowall, of Johnstone; this we shall shortly be in a position to explain by an engraving.

Mr. Beattie, builder, of Edinburgh, exhibited a full-sized air spring of his invention, for closing house doors. It is simply an arrangement of two air cylinders fitted with air-tight pistons, the rods of which are geared with a pinion fast on the central pivot of the door. By this means, the pressure of the atmosphere acts on each piston, when the door is moved in either direction, forming a double spring. We should say this scheme would be far too expensive, and, moreover, the piston will hardly keep tight enough.

The following is a list of the various prizes:—

Section 1. William Ralston, Malletsheugh Mearns, Renfrew, dressing-fan for cleaning and separating grain, made by exhibitor, improved—£5.

3. Richmond and Chandler, Salford, Manchester, linseed mill, made by exhibitors, improved in adjustment for feeding and crushing—£5.

4. Richmond and Chandler, Salford, bean and oat mill, made by exhibitors, improved in adjustment for feeding and crushing—£5.

5. James Kirkwood, implement maker, Tranent, horse-rake—£2.

9. William and James Hunter, Samuelston, Haddington, lever corn or grain drill, made by exhibitors, improved in the construction of the coulters—£4.

10. Richard Garrett and Son, Leiston Works, drill for grain and vegetable seeds, made and improved by exhibitors—£5.

11. James Kirkwood, Tranent, turnip-sowing machine, made and improved by exhibitor—£3.

13. Robert Law, Shettleston, broadcast sowing-machine, made and improved by exhibitor—£3.

14. Thomas Inglis, smith, Slack, Peeblesshire, ribbing-machine, made by exhibitor, improved to answer any size of drill—£3.

15. Gray and Greenshields, Stane, Shotts Iron-works, Whitburn, 2-horse plough, made by exhibitors, second best—15s.

15. James Wilkie and Company, Uddingston, Glasgow, 2-horse swing-plough, made by exhibitors, joints and mortices dispensed with—£3.

16. Hugh Cowan, Corstorphine, double mould plough, made and improved by exhibitor—£2.

17. R. Gray and Sons, Uddingston, Glasgow, subsoil-plough, made by exhibitors, and improved by Mr. Robert Wilson, Drumby, Ayrshire, combining lightness with great strength; will work in light soils with two horses, but will stand six in heavy soils—£3.

18. Hugh Cowan, Corstorphine, pair of harrows, made by exhibitor—£3.

19. Richard Garrett and Son, Leiston Works, horse-hoe, made and improved by exhibitors—£5.

20. Robert Gray and Sons, Uddingston, horse-hoe, made by exhibitors, improved with mortices in frame—£2.

21. Hugh Cowan, Corstorphine, 2-horse grubber, made and improved in construction by exhibitor—£3.

22. Alexander Slight, cylinder chaff-cutter, made by exhibitor, and improved in the form of cutting-box and knives—£5.

23. James Waddell, Kettins, Coupar-Angus, turnip-cutter, made by exhibitor, improved in speed and correctness in working—£2.

24. James Kirkwood, Tranent, turnip-cutter for sheep—£2.

28. George West, Riccarton, Linlithgow, clay-mill and grater, made by exhibitor, improved in construction—£10.

29. Henry Clayton, 21, Upper Park Place, Dorset Square, London, "cycloidal" (or improved Essex shape) draining tools, with polished or ordinary black blades, invented and manufactured by exhibitor. Improvement consists in superiority of "cycloidal" over old "scoop" shape, in point of permanency of edge, strength, and lightness of blade—£2.

32. James Wallace, Eaglesearnie Tile-works, Haddington, collection of drain tiles and pipes, made by exhibitor—£4.

33. Redpath, Brown, and Co., cart and live cattle weighing-machine, made by J. Craig, Liverpool. The arrangements of this machine are new: the platform rests solid on firm bearings, and the centres are at rest except when the weight is to be observed; platform, 6 feet by 3 feet 6 inches—£10.

35. William Crosskill, Beverley, liquid manure-cart, for distributing either broadcast or four rows at once, made by exhibitor. Improved in the form and construction of the tank, outlet-valve, and watering apparatus—£5.

36. William Dodds, Haddington, press wheel-roller for pulverizing land, made by exhibitor; invented by Mr. Cambridge, Market Lavington, Devizes; improved in construction—£5.

37. David Craig, Stewarton, Ayr, thrashing and dressing machine, improved and made by exhibitor. The improvement consists in having a vibrating riddle placed under the shakers for riddling out the straw and black tick, delivering the corn into elevators, by which it is carried into double-blast fanners, and runs from thence into bags—£5.

38. R. Buchanan Forbes, Possill, Glasgow, farm-cart, made by exhibitor. All wearing points in the smith-work are properly steeled and hardened—Gained the medal.

38. R. Gray and Sons, Uddingston, Glasgow, improved 1-horse tilt farm-cart, made with broad wheels, &c., made by exhibitors—Gained the medal.

38. Robert Law, Shettleston, cart for general farm purposes, made and improved by exhibitor—£5.

41. David Scott, Glasgow, set of farm-harness, including back-bands and plough-chains, made by exhibitor, improved in the whole of the harness being made up with spring hoops—£2.

41. Waldie and Hunter, Kelso, cart-saddle, made and improved by exhibitors. The improvement consists in the boards and pannels being moveable, by which means they adjust themselves on the horse's back, enabling the horse to work with greater ease—Medal.

42. John Cunningham, Edinburgh, light skeleton plough, invented by exhibitor, and made by John Aikman, Balerno. This plough is of light construction, lessening the surface and diminishing the draught. The coulter fits into a round box, to enable its edge to be turned as may be most suitable; a moveable plate is fitted on the left side, to make it act as a bulking plough, or for drawing drills. It is also fitted with a muzzle of a new construction. It is especially intended to save small farmers the expense of a bulking plough—£5.

42. R. Gray and Sons, Uddingston, parallel lever subsoil-pulverizer, made by exhibitors. This implement is distinguished from others by the peculiar position and form of its tines or pulverizers, three in number, placed diagonally in the frame. The arms of the first and last tines are inserted into horizontal mortices in the frame, and can be expanded or contracted at pleasure to the breadth of furrow subsoiled. By this arrangement of the tines, a saving of power is gained, and, at same time, the complete disintegration of the subsoil effected. The work of this implement is the same as if done with the fork, no part of the subsoil escaping the action of its pulverizers; is lighter of draught than subsoil ploughs, and makes better work in land free of fast stones—Medal.

42. James Kirkwood, Tranent, Norwegian harrow, made and improved by exhibitor—£2.

PATENTED ARTICLES.

Henry Clayton, London, patent double action hand-working machine, for freeing or separating the clay from stones, roots, or other extraneous substances, and the manufacture of draining pipes from 1 inch to 6 inch bore, and all kinds or shapes of draining, flat, and ridge tiles, bricks, &c., invented and manufactured by exhibitor. The machine is wholly made of iron, and constructed for working either upon the vertical or horizontal planes. It has adjusting springs to the cutting part, which keep a uniformity of stretch to the wires, and produce a perfectly square cut. The gearing is eased over with portable covers, to prevent the clay and grit working into the moving parts. The improvement in separating and preparing the clay consists in the use of metallic gratings instead of wire sieves—£10.

William Crosskill, Beverley, patent serrated roller, or pulverizing land-roller, for pulverizing cloddy land, compressing light soil, and rolling cultivated crops, invented and manufactured by exhibitor, improved in the separate action of each alternate revolving disk or roller part, made larger in the eye for increasing the mechanical action along the entire surface of the serrated roller, and effecting the means of self-cleaning—£10.

John Young, engineer, Ayr, registered pipe and tile making machine, made and invented by exhibitor. In this machine, by means of covered cylinders, the clay is first flattened into the form of a web, which in its progress over various-shaped rollers, is formed into the tile or pipe required; these, in their turn, are cut off by a travelling apparatus, cutting without stopping any of the principal movements—Medal commended.

EXTRA ARTICLES.

John Todd Alexander, Maxwelltown, Dumfries, ornamental or fancy chair, for garden or pleasure grounds, made by exhibitor.

Richard Garrett and Son, Leiston Works, Suffolk, model of thrashing-machine, on the most improved principle, made and invented by exhibitors.

Charles Miles, Great Russell Street, London, field-gate, invented and improved by exhibitor; advantages of strength, permanency, simplicity, and economy obtained, by using cast-iron in conjunction with wood in the construction.

Redpath, Brown, and Co., Edinburgh, warehouse weighing-machine, made by J. Craig, Liverpool, for general purposes.

Richard Robinson, Eliza Street Works, Belfast, steaming apparatus, for preparing food for cattle, pigs, &c., made by exhibitor. The furnace of boiler enlarged, and a glass water-guage added, by which the supply of water required may be seen.

James Slight, Edinburgh, linseed-crusher, made by exhibitor.

Francis Taylor, 6 Lawrie Street, Leith, portable chair, made by exhibitor.

C. D. Young and Co., 128 High Street, Edinburgh, a carriage-gate, complete, with cast-iron posts.

William D. Young and Co., 54 Hanover Street, Edinburgh, stack-frame and pillars.

The collection exhibits a great increase over former years. It still contrasts remarkably with the exhibition of the Royal Agricultural Society, the entries being only as 310 to 1508. The latter exhibition, when held at Oxford in 1839, only produced 23 implements, when it increased rapidly up to 1844, in which year 948 were shown. Subsequent to this date, a falling off took place; but the spirit of competition has since revived to such an extent, that in 1847, the Northampton Show numbered 1321; and this year, at York, 1508 were entered.

Mr. Hornsby, of Grantham, out of 17 articles exhibited, obtained prizes for four, amongst which was a six-horse portable steam-engine—an assistant only now beginning to be appreciated by farmers. It is in the

form of a locomotive, with a circular fire-box. The cylinder is placed horizontally immediately in front of the fire-box, driving a crank shaft, supported in pedestals close to the chimney at the opposite end of the boiler. The whole stands on four waggon wheels, so that it may be conveyed to wherever its services may be required. The prize for this was £50. Of the remaining prizes, three were obtained by Mr. Bushy, two by Messrs. Howard and Son, two by Mr. Crosskill, two by Mr. Garrett, and two by Messrs. Sharman and Co.

PROCESS FOR MANUFACTURING LEATHER ARTICLES WITHOUT A SEAM.

A peculiar method of manufacturing different hollow articles wholly of leather, without a seam, has been invented by Messrs. Durand and Pecquer in Paris. A series of articles manufactured by these gentlemen having been laid before a committee of the Franklin Institute by M. Rabeau, that body has signified its high approval of the plan. The principle of the method is, the division of the leather in a moistened state, in the direction of the plane of its length and breadth, making, in the case of fire-hose, a slit through its entire length, leaving a border on both edges uncut. The cutting operation is performed by means of a short knife attached to the extremity of a steel rod, to which a reciprocating motion is communicated, somewhat similar to the plan pursued in this country in the splitting of leather for the manufacture of cards for textile purposes. An immense number of articles may be made by this process, as sword scabbards, canteens, military caps, spectacle cases, and even boots and shoes.

In the manufacture of canteens, a piece of leather of the requisite shape, and a little broader than the vertical section of the finished article, is slit up, leaving an uncut border of uniform breadth. The leather is always wet when cut, and the opening thus made is filled with sand, and a plug is driven into its mouth, so as to keep the bag distended until it dries, when it may be finished by any of the known methods. Melted wax, or a preparation of wax, is poured into the interior, to fill the pores of the leather, and thus prevent the infiltration of any liquid with which it may be filled. M. Rabeau proposes to finish up the shape of canteens, by subjecting them, when filled with sand, to hydrostatic pressure in suitable moulds.

The most curious branch of this interesting process is the manufacture of shoes, which, with the single exception of the heel-tap, are completely finished out of one piece of leather. In making a shoe, a piece of sole leather of the shape represented in fig. 1, is required. The cutter is first introduced along the line, *a*, slitting the leather in the shape of the dotted line, to the end, *b*, which forms the toe. It is then again introduced at the line, *c*, slitting it up to the contrary end for the formation of the heel. It is now ready for the reception of the last, when the uncut border assumes the position of the dotted line in fig. 2. This border is then neatly pared down even with the surface of the shoe, and, when finished, this part cannot be distinguished from the uncut surface. Boots are finished by a similar but more complicated process. The committee have given their opinion that the scabbards made by this process are much superior to the old kind, as, from the absence of seams, far less wear will be experienced. In fire-hose, rivets are still necessary for holding together the edges of the leather, and some doubt exists as to the capability of the diminished thickness of material for standing the required pressure of the water, although, according to M. Rabeau's trials, a section of it resisted an internal pressure of 120 lbs. per square inch.

Fig. 1.

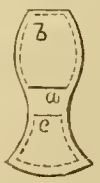


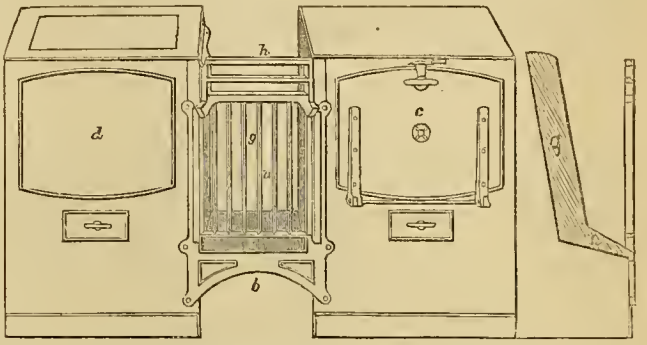
Fig. 2.

As far as we can see the rationale of the process, its most valuable application will be to the covering of the drawing and other rollers used in spinning machinery. Every spinner well understands the very great objections attending the use of spliced cylinders of leather for the coverings of rollers, where the most complete exactitude of surface is indispensable. The spliced coverings gradually expand and become loose, so as to require frequent renewal, and the inequality of surface caused by the overlapping at the joint seriously affects the regularity of the thread. In the new process, a slit is cut in a piece of leather of the proper size, and a mandril is introduced into the opening so as to fit tightly. The mandril with its leather covering is then set in the lathe, and turned perfectly smooth and round. It becomes a question, whether leather thus prepared will possess the requisite amount of elasticity, in order to accommodate itself to the thread in working. This is said to have been met by the advantage of the more perfect cylindrical shape of the roller, so that the same degree of elasticity is not required.

NICHOLSON'S NEWARK COTTAGE RANGE.

This is a valuable adjunct to the economics of the kitchen, and the Royal Agricultural Society have evinced a sound discrimination in awarding it their premium, as the best of thirty-two arrangements brought before them at their late meeting. Fig. 1 is a complete front elevation of the range; fig. 2 is a transverse section through the centre of the

Fig. 1. Fig. 2.



grate. The fire range, *a*, consists simply of a row of six vertical bars cast in a frame, which is fitted to slide vertically in grooves, formed by a detached frame piece, *b*, screwed to the front of the oven, *c*, and boiler, *d*. By this simple means, poking is done away with, as the mere raising of the front frame permits of the free escape of the ashes and cinders from the inclined bottom of the grate at *e*, fig. 2. The back of the grate, *g*, is formed of fire-clay, in one piece with the bottom, *e;* it is also inclined forward at the angle, shown in fig. 2, and a very narrow space is left between it and the front bars, so that the mass of the fire is narrowest in the line where it is of the least use.

A fall bar, *h*, is hinged to the top of the frame, in such a manner that it may either be let down directly over the fire, or, by reversing its direction, it will come over the hearth, according as a greater or less heat is required for the article or vessel to be placed upon it. The door of the oven, when turned down, answers as a convenient hot plate. The cost of the article complete, as in our cut, is from 35s. to 55s., for openings from 3 ft. 2 in. to 4 ft. wide.

DEATH OF GEORGE STEPHENSON, ESQ.

Long before our Journal will be in the hands of its readers, the newspapers will have informed them of the death of this distinguished engineer, which took place at his residence, Tapton House, near Chesterfield, on the 12th ult. The immediate cause of death was a fever, the origin of which is not known, but its virulence proved fatal in eight days. He had attained his 69th year, but his powerful frame gave no signs of decay; and, but for the attack of fever, he might, in the ordinary course of events, have lived many years.

That his mental vigour was by no means impaired, our own pages bear evidence; for it will be seen that he attended in person at the last meeting of the Institute of Mechanical Engineers at Birmingham, and read his promised paper on the "Fallacies of the Rotatory Engine." The loss of his presidency will be severely felt by this young Institution; and the profession generally will own, that a great man has passed from amongst them.

RECENT AMERICAN PATENTS.

IMPROVEMENT IN PLANING, TONGUING, GROOVING, &c., PLANKS.

JOHN CUMBERLAND.

The patentee says,—"The nature of my invention consists in passing the board or plank to be reduced and planed first under a roller or rollers, whose surface is composed of a series of sharp edges, parallel with the axis, to form cutters, which, in rolling over the board, makes cuts in its surface of the required depth, and at distances apart equal to the spaces between the cutting edges; and then in shaving off the projections thus formed by means of one or more plane irons, leaving the surface smooth, whether these operations be performed by carrying the roller or rollers, and plane or planes, over the board or plank placed on a permanent platform, or whether this be fixed or connected with a permanent frame, and the board or plank be carried to and by them by means of a carriage."

Claim.—"What I claim as my invention, and desire to secure hy letters patent, is the method of reducing boards to equal thicknesses, or widths, hy passing them under the action of cutting or scoring wheels, which cut into the surface, substantially as herein described, when this is combined with another cutter or cutters, which cuts off the parts scored or indented, substantially as herein described.

"And I also claim, in combination with this, a smoothing plane or planes for smoothing or shaving the surface, substantially as herein described. And I wish it to be understood, that I claim this method of reducing and planing planks or boards, &c., whether for planing the surface, tonguing, or grooving or cutting mouldings."

IMPROVEMENT IN RACK WRENCHES.

Zelotus W. Avery.

The patentee declares,—"The nature of his invention and improvement to consist in forming the wrench with a cylindrical chamber in its largest end, extending entirely through it, having a circular seat formed around the same for the reception of a number of cylindrical revolving notched cores or nuts of uniform diameter, fitted to said circular seat, having a square or polygonal opening, in the centre of the same, corresponding with the size or shape of the nut or head of the screw to be turned, which is received into said square, or polygonal opening—the said nut being made to turn with the wrench when turned to the left, hy means of a pall, attached to the wrench by a pin and spring, and engaged with a tooth of the nut—said pall, when the wrench is turned to the right, slipping back over one or more teeth of the nut without turning it, and being again engaged with another tooth of the nut, and the wrench again moved to the left, causing the nut to turn with it, and to turn the screw to which the nut is applied; and thus, by a repetition of the aforesaid operation, causing the screw to turn as many times as may he required without disengaging the wrench therefrom, hy simply moving the handle to the right and left in the arc of a circle, vertically, or horizontally, or obliquely, to any degree required, being adapted to the turning of any sized screw, by merely changing the cylindrical nut or core, without changing the wrench circle, and handle, and its appendages—the revolving notched nut or core being held down upon its seat in the circular chamber of the wrench, by a turning catch attached to the wrench, and made to overlap the rim of the core or nut."

Claim.—"I claim as my invention, the peculiar mode or manner of adapting the wrench to the turning of screws, bolts, or nuts, or other articles, made with square, polygonal, or other shaped heads, hy means of the changeable cores, constructed as above set forth, and represented, in combination with the turning catch for holding the revolving core to its seat, as constructed and operated, as above described."

IMPROVEMENT IN PREVENTING EXPLOSIONS OF STEAM BOILERS.

Alfred Stillman.

The patentee says:—"The nature of my improvement consists in the use of a tube, one end of which is stopped by fusible metal, and rests upon some part of the boiler liable to he overheated from a deficiency of water, while the other end opens through the external part or shell of the boiler to allow the escape of steam to give alarm to the person in attendance, whenever the fusible metal should become melted hy the overheated boiler, and so arranged that the issue of steam may he stopped at pleasure, and the fusible metal subsequently restored to its place with very trifling labour or detention."

Claim.—"What I claim, and desire to secure hy letters patent, is the application to steam boilers of a tube, constructed for the purpose, or in the manner herein described, and stopped with a cap. or any other shaped piece of fusible metal resting upon a part of the boiler liable to become overheated in the absence of a proper supply of water, and designed for the purpose and objects herein substantially set forth."—*Franklin Journal.*

REVIEWS OF NEW BOOKS.

A Familiar Explanation of the Higher Parts of Arithmetic: comprising Fractions, Decimals, Practice, Proportion and its applications, &c. By the Rev. Frederick Calder, B.A., Head Master of the Grammar School, Chesterfield. London: Whitaker and Co. 1848. Pp. 167.

Elementary works of this kind are hy no means of easy estimation, for they demand the closest examination of the reviewer for the detection of their imperfections, or the due appreciation of the steps they have taken towards improvement. Time and space seldom permit of a sifting process sufficiently complete, and we can do little more than furnish some explanatory information upon the chief items of novelty touched upon by the reverend author. His preface tells us truly enough, that pupils in arithmetic are too often taught mechanically, and without reference to any practical demonstration of the principles of the rules they are following. He advocates the initiation of the pupil into fractions, decimals, and practice, previous to entering upon proportion and its applications; but as the student is thus kept back from proportion to a late period, he has explained the leading principles of proportion under the head of fractions. This is doubtless an improvement upon former arrangements, and is worthy of the consideration of all instructors who undertake the difficult task of leading youth through the difficult passes of early calculations.

In the conversion of circulating decimals into vulgar fractions, the algebraical method is employed, and we think judiciously so.

The book, as a whole, exhibits many simplifications of arithmetical details, sufficient to elevate it considerably above the rank of a mere school-book. The fictitious rudimentary grounding which falls to the lot of many in early years, renders doubly valuable such explicit works as the present; for they smooth away the difficulties continually experienced by the self-instructor. To this class, above all, we may recommend Mr. Calder's production as a philosophical text-book.

CORRESPONDENCE.

CORROSION OF STONE FLOATS IN STEAM BOILERS.

In terms of the permission accorded by you to all parties who may require a little light in matters indistinctly understood, I beg to lay before you the particulars of a practical difficulty which I have met with, in the hope that it may receive some elucidation in your pages.

I am in the habit of putting stone floats to water guages for regulating the height of water in steam boilers, and find that the stone is subject to rapid decomposition in many high-pressure boilers in this town. You will he aware that this may lead to serious evils, as the gradual lightening of the float will indicate an incorrect level of the water. I have tried various kinds of stone, hut all are alike subject to corrosions, although the water is supposed to be pure. It is raised from a pit, but contains none of the red matter usually found in coal pits or iron in solution.

Burnley, July 31, 1848. B. S. H.

DECIMAL SYSTEM OF CURRENCY.

I perceive that your correspondent, J. L. M., is but partially acquainted with the subject of decimal currency, from the fact of his recommending the identical system proposed to the House of Commons last year hy Dr. Bowring, with only a new nomenclature. The idea of a decimal currency, based upon this system, could not be entertained hy the honourable members, because it reduces the value of existing copper coins $\frac{1}{24}$th part; therefore, the motion was withdrawn. Let me ask your correspondent, how could the poor hear such a loss? or how could hucksters, shopkeepers, and manufacturers alter their prices containing shillings, pence, and farthings, so as to sustain neither gain nor loss when represented in the decimal coins? It is utterly impossible to find an equivalent for any sum of pence and farthings under one shilling in the decimal coins of that system; consequently, either the seller or the buyer must suffer a loss. This objection may possibly appear trifling at first to others besides Mr. J. L. M.; but, upon consideration, they must see that its effects would produce an immense derangement in prices. This objection has been fully stated elsewhere. I last year published in "Howitt's" and "The People's" Journals, as well as in several newspapers, an exposition of my system, in which these points were argued. The other system was also published by Dr. Bowring in the same Journals, in which he fully explains his plan; none of which papers, I presume, your correspondent has seen.

By my paper in your last month's Journal, he will see that his new names are not altogether original; my three systems of names therein explained, were also published last year (1847). I give him credit for personal originality; hut yet I respectfully recommend him to examine carefully all that has yet appeared, so that he may he prevented treading in anterior footsteps. I have not rashly invented my system: it has cost me a great deal of thought; and I now confidently leave the matter in the hands of Parliament and the public, to decide when they will introduce a decimal currency, and also which system it shall he based upon.

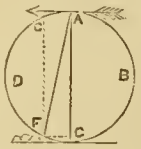
Your correspondent will doubtless have learned, from my papers in your Journal, that any sum, either small or large, in £ s. d., can be exactly

represented in coins of my system, without either a diminution of, or addition to, its value. This point, I would just observe, is of more importance than the question of trouble; but I would likewise inform him, that the public can adopt my "round-about" system with as little trouble or inconvenience as the other, and, what is of more consequence, without any loss to any party. I may inform J. L. M., and your readers generally, that, as I have before stated, no new system, whether good or bad, can be introduced without a little trouble at first, till it is perfectly understood and rendered familiar, and that I also know how averse the general public is (as Mr. T. Craddock justly remarks) to any *great change*. The subject has now, however, been broached; it rests, therefore, with our ruling powers, how long they will allow the present absurd, troublesome, and incongruous system of £ s. d. to be tolerated in this kingdom. Late though it may be, yet I believe that a change will be made in English coinage; for the example has already been set us by neighbouring nations. Let any person look over a list of American and Continental coins, and they will observe that several nations already possess a decimal coinage.

JACIA.

SOLUTION OF PROBLEM, PAGE 19, PART I.

In the following diagram, let A B C D represent a cylinder, and F a certain substance opposed to it.



We have to roll the cylinder, A B C D, over the substance, F, and also to crush it at the same time.

In order to effect this, there are two powers given, denoted by $P + x$ lbs.: the one, P lbs., to urge the cylinder forward; and the other, x lbs., to overcome the resistance of the opposing obstacle.

It is required to know whether "the value of x be less, the greater the value of P, supposing that the road, substance, and rate of motion remained the same?"

Now, supposing $P + x$ lbs. act upon the cylinder in the direction indicated by the arrow, we shall have it in fact acting in the line, A F, and with the leverage, A F. In this case, it is a lever of oblique action. Let us proceed to calculate for bent levers.

The rule is, in order to produce equilibrium, the weight multiplied into its distance from the fulcrum must equal the power multiplied into its distance from the same point. These distances are called the "arm of weight," and the "arm of power," respectively.

In the diagram, the dotted line, C F, drawn at right angles to C A, represents the "arm of weight;" and the dotted line, G F, drawn at right angles to A G (the direction in which the power is applied), represents the "arm of power."

From these the calculations are to be made.

Let the gross weight to be overcome be equal to, say, 24 lbs., and let the lengths of the arms of weight, C F, and power, G F, be equal to 2 and 12 respectively—then,

According to the rule just stated—

$$24 \times 2 = 48$$

and $48 \div 12$ (the length of the arm of power) $= 4$

$\therefore$ 4 lbs. will be the amount of power required to produce equilibrium, which power is represented in the question by $P + x$ lbs.

Again, suppose the diameter of the cylinder was increased, the arms of power and weight would also be increased, but the arm of power would be increased in the greater proportion.

Say, for instance, that their proportionate increase is as 2 to 1;

Then we shall have—

$$G\,F = 24$$

and $C\,F = 3$

then 3×24 (the gross weight) $= 72$

and $72 \div 24$ (length of G F) $= 3$

—that is, where 4 lbs. were before required to do a certain amount of work, only 3 lbs. are, in the present instance, required to do the same, consequent upon the advantages resulting from an increased leverage.

It appears, then, that the greater the diameter of the cylinder, the less the power required; and therefore it is self-evident, that the value of one or other of the powers, P or x, must diminish. If the superfluous power is taken away from P, then x will remain the same; and if, on the contrary, the value of x is diminished, then P will remain the same.

We therefore arrive at this conclusion, that the greater the diameter of the cylinder, the less will be the power required to be elicited from x, if P is unaltered, or x becomes less, the greater the value of P.

And, as the foregoing proof will at the same time serve to elucidate the second question—both of them hanging so closely together as scarcely to admit of being handled separately—we draw the inference, that the less power will be required to perform the work with a large cylinder than a small one.

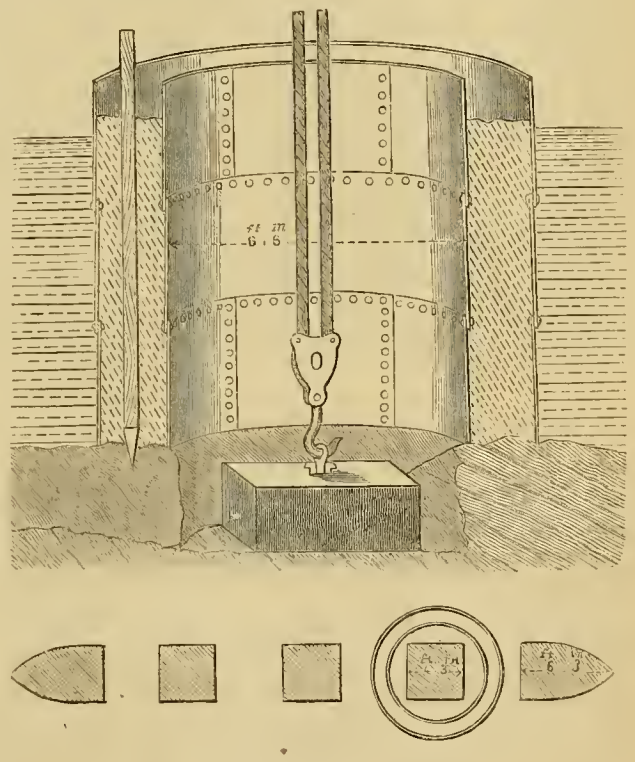
CHAS. ADLEY.

WROUGHT-IRON PORTABLE COFFER-DAM.

I have read with much pleasure the description of Mr. Stevenson's "Portable Coffer-Dam" in your Journal for August, and the more so because I have, within the last few days, completed the foundations of a pier for the Springfield Bridge over the river Irwell, by means of a contrivance of a similar nature.

The arrangement to which I refer is a portable coffer-dam, formed by two cylinders composed of $\frac{3}{8}$ inch wrought-iron plates riveted together, the outer one being 9 feet, and the inner one 6 feet 6 inches diameter, and both 8 feet high. The depth of the river varies from 4 to 7 feet, so that the iron cylinders, when placed in the deepest part of the river, were about a foot above the water level.

The current in the Irwell being rather strong at the point where the Springfield Bridge is now erecting, it was found necessary to lay down a cut-water at each end of the pier, which is composed of five stone pillars. The annexed sketch is a plan of the whole pier, showing the two cylinders serving as a coffer-dam. The whole of the pillars are united by strong wrought-iron cramps above the water line, and carry a stone entablature at the top.



The cylinders having been placed in the middle of the stream, and sunk as low as possible through the loose gravel at the bottom, I had all the loose stones removed from the annular space between the two, and filled it with strong puddle, made of clay and straw well worked together. The water was then pumped out of the inner cylinder, until the bed of the river was in sight. In those parts where the cylinders touched the rock, the joint was perfect; but in one place a little water found its way in, owing to the bed of the river being partly composed of gravel. The leakage was, however, easily stopped by driving in a few 3-inch sheet piles. After clearing away about two feet of the rock and stones from the bed of the river, an excellent foundation was obtained, and the first stone was laid, as seen in the sectional view of the dam—a hand-pump of 4 inches bore being sufficient to keep the interior free from drip water.

The whole apparatus answered so well, that one pillar was put in each day to above the water level, and the dams were removed from one pillar to another in about 18 hours, or from 3 A.M. to 9 P.M. of the same day, the last pillar of the series having been laid on the 29th of last month.

THOMAS DUNN.

Windsor Bridge Iron-works, Manchester,
August 10, 1848.

IMPROVEMENT IN LOGARITHMICAL TABLES.

Having often had occasion to use logarithms in computations where large numbers are required, I have met with great difficulty from the want of tables sufficiently extensive. Hutton's are, without doubt, the best and most correct, but they only extend to No. 10.799, so that, when I require the log. of a larger number than this, I am obliged to compute it by means of the difs. and pro. parts. This is a slow system, and it is, besides, excessively troublesome for young pupils to comprehend. In addition to this, I have noticed one great point of superfluity in the tabulation, by avoiding which, one-tenth of the figuring may be saved. I refer to the logs. of Nos. with one or more ciphers to the right hand, since the log. does not alter for any No., whatever ciphers may be appended to it, the characteristic alone being increased. For these reasons I have been induced to plan a new set of tables, in which all Nos., multiples of 10, are omitted; for if the log. of the significant figures in the number are found, then, by adding 1 to the characteristic of that log. for every cipher in the given No. we have the required log. At one time, I intended to make my new tables subsidiary to Hutton's, by commencing where he leaves off; but I now mean to rewrite the whole, so as to render one set sufficient.

I subjoin the commencement of my table, extending as far as 100.001 to 7 figures; but for Nos. of 6 figures, their logs. will be increased to 8, without their characteristic. The reason for this is, that they may be true in their last figure. By my arrangement, I dispense with 99.999 Nos. and logs., a number almost equivalent to the whole amount of Hutton's tables; and, further, the columns of difs. and pro. parts are not required.

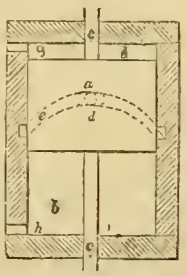
1.	0000000
2.	3010300
3.	4771213
4.	6020600
5.	6989700
6.	7781513
7.	8450900
8.	9030900
9.	9542425

In connection with this subject, I may remark, that it is probable that a decimal system of coinage will be shortly introduced into England. Your own pages have given one of the best schemes for this desirable object, the supporters of which will readily see the advantage conferred by my tables in making decimal monetary calculations. Every sum of money will, in the decimal system, assume the form of a decimal fraction, and logs. may be found to represent them, as if they were simple decimal quantities.

LOGARITHMICUS.

ROTATORY ENGINE.

The accompanying sketch represents a design for a compound rotatory and vibratory engine. *a*, Is the piston, fast on the rod, *b*, which projects at each end of the cylinder, *c c*. The piston carries a traversing stud, *d*, which works in an oblique traverse groove, *e*, cut round the entire interior circumference of the cylinder, and one half of which only is shown in dotted lines. The steam ports are at *g*, *h*. The figure represents the port, *g*, as being open, and the steam pressure is consequently acting upon the upper end of the piston, which thus has a compound motion, as, in endeavouring to traverse to the contrary extremity of the cylinder, the action of the stud, *d*, causes it to make a half revolution during its down stroke. At the return stroke, in passing upwards, it makes a second half revolution, and thus the motion is continued. The piston rod, *b*, will of course have the same compound motion, but its rectilinear movement may be compensated in a simple manner by a traversing feather.



In many cases it might be advantageous to make the motion single-acting only; in others, the double action would be necessary, as for marine purposes, where the paddles might be placed directly on the piston rod, the extremities of which would traverse through them.

8 *Mount Row, New Kent Road, London.* STEPHEN SHARP.

THE MECHANIC'S LIBRARY.

Arithmetic, System of, with Key, post 8vo. 3s. cloth. Walton and Henn.
Chemistry, Rudimentary, 12mo., 10d. cloth, sewed. G. Fownes.
Churches, Castles, Remarkable, 1st series, 4s. W. S. Gibson.
Constructive Maps, folio, 3s. sewed. Collins.
Mensuration, Bonnycastle's, 20th edition, 4s. 6d. S. Maynard.
Millwright and Engineer's Companion, 8th edition, 5s. W. Templeton.
Perspective Drawing, new edition, oblong, 3s. half bound. W. Symm.
Perspective, Rudimentary, Parts I. and II., 12mo., 10d. cloth, sewed; III. and IV., 10d. G. Pyne.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF MECHANICAL ENGINEERS—GENERAL MEETING, BIRMINGHAM, JULY 26.

GEORGE STEPHENSON, ESQ. PRESIDENT, IN THE CHAIR.

The opening paper of this meeting, was the President's dissertation "On the Fallacies of the Rotatory Engine," deferred from last month. The President having alluded to the model of Mr. Onion's rotatory engine then before the meeting, invited the fullest discussion on his paper and on that model, his own views being illustrated by a diagram.

As all levers give out their powers at right angles to their fulcrums, it will be seen that the right angle line, I, (referring to the accompanying diagram,) from the connecting rod to the centre of the beam, will be the true measure of the length of the beam, when the crank is at half stroke; therefore, $\frac{1}{10}$ of half the length of the beam will be gained by the piston end of the beam. The crank being 3 feet long, the up and down stroke of the piston will be 12 feet; the crank pin will, of course, have passed through a space of nearly 19 feet.

Now, a weight hanging upon the drum, which is nearly four feet in diameter, will balance the same weight on the piston end of the beam; each will move at the same velocity, and pass through the same space in the same time.

It will be observed, that from C to D is a little more than $\frac{1}{3}$ longer than from C to D: it will therefore be seen, that the weight at the piston end of the beam has a little more than $\frac{1}{3}$ advantage over the weight at the drum. And it will also be seen, that from C to E is half way from half stroke to the bottom centre; at this portion of the stroke, the leverage of the crank will be nearly 2 feet. The increased power that existed in the crank from half stroke to this point, will gradually be lost from E to H: it is, therefore, clearly proved, that no power is lost by the crank motion, as the weights resolve themselves into a simple lever. There will be a little loss of power when the engine is turning the centres, which is compensated for at the connecting rod end of the beam, by the segment of the right angle line, I.

Now, a rotatory engine can only give out its power on the arm, like any other lever; and if the piston passes through a space of 19 feet, it will just balance a weight equal to the same power passing through the same space.

The President went on to observe, that the fallacy of Mr. Onion's principle was pretty conclusively proved by the fact, that fifty patents, at least, had been taken out for rotatory engines, every one of which had failed. No man who ever lived could improve on the lever principle, as there was no power but in the lever. He would now be glad to hear the opinions of the members, and also any explanation that Mr. Onion might wish to offer.

Mr. Onion then stated, that his engine had been working for some weeks at the Derby station, by permission of Mr. Kirtly, the locomotive superintendent of the Midland Railway; and, during that trial, experiments with his and another engine had proved that his effected a material saving in fuel. A statement to that effect, authenticated by Mr. Kirtly, was now in the possession of Mr. M'Connell, at whose suggestion he attended that meeting. The President said, that it appeared to him to be impossible that such could be the case. The engine might have answered at one trial, but it might fail at the next; and one trial was by no means a sufficient proof. Mr. Slate observed, that there was one important desideratum which he desired to see obtained in the rotatory engine,—namely, some method of packing tightly. That had never yet been found. He had paid much attention to the rotatory engine, and had seen approaches made to an efficient system of packing, but none had been so perfect as to render the rotatory principle equal to the crank. Mr. Onion had told them that his engine was more simply packed than the common engine, and he should like to have that made quite clear to the meeting.

Mr. Onion said, that Mr. Scott Russell, who had written on, and patented several, rotatory engines, confessed to him, that he (Mr. Onion) had succeeded in overcoming difficulties which had hitherto been found to be insurmountable; such as making his engine steam-tight, and also doing away with the usual noise of the rotatory engine. He was satisfied that his engine would bear a comparison with one upon any other principle. Mr. Joseph Miller said, that one great advantage of the rotatory engine, supposing it to be thoroughly efficient, was the small space which it occupied. If it were made as perfectly tight as the ordinary engine,—admitting that tightness was one of the advantages of the common crank engine,—a useful result would be accomplished. He had never yet seen a rotatory engine rendered sufficiently tight, but he would not go the length of saying that it could not be done. As a practical man, however, he saw great difficulties in the way. He had never seen a rotatory engine which remained tight for any length of time; and he should as soon expect to discover the perpetual motion as to make one which would. The President observed, that if he believed there was anything in Mr. Onion's engine, he would be very happy to give his assistance in bringing it before the public; but he really could not see anything of value in it. Mr. Miller thought that the question of the crank and the rotatory engine ought now to be finally settled. It was very desirable that that should be done.

On being referred to, Mr. Henry Robinson said, that the Government had a rotatory engine (Lord Dundonald's) working in the Portsmouth dock-yard for the last seven years. Mr. Onion claimed the credit of being the first who had ever succeeded in packing efficiently, but it was only the same as he (Mr. Robinson) had been in the habit of using for years; Mr. Onion, had not, therefore, advanced anything at all new. If Mr. Onion would call upon him in London, he would show him an engine similar to his own, and packed in the very same way. It is one that was applied to a locomotive, and commonly known as the "Jim Crow Engine,"—from its having been painted black. The difficulty with rotatory engines had hitherto been in keeping them tight. The difference between Mr. Onion's engine and the one at

Portsmouth dock-yard was, that in the latter, the packing did not depend upon springs. All that he (Mr. Robinson) was prepared to say about that engine (Lord Dundonald's) was, that it had hitherto done the work which it was intended to do. The President asked if any member was of opinion that there was a loss of power by the use of the crank? They had heard his reasons for asserting that there was no loss; and he wished that those who entertained a contrary opinion should declare it.

A member having spoken of Beale's rotatory engine, the President stated that he had been concerned in having a trial made of that engine in a steam-boat intended to carry passengers a short distance of only half a mile, to Yarmouth; but when the engine was put to work, he could not get the boat to move forward, and so the experiment failed. He managed to get the boat to sea, and it cost him and his party £40 to bring her back again. As to Lord Dundonald's engine, he was invited, on one occasion, to see it tried on the Liverpool and Manchester Railway; but he refused to go, because he was convinced that a failure would be the result, and so it was,—for the engine could not be made to draw a train of empty carriages.

Mr. Robinson: But I think you will agree with me, sir, that there is no loss of power consequent upon the principle of the rotatory engine.

The President: Not if you make it tight.

Mr. Robinson: The object of the rotatory engine is to economize space and power; and if we cannot attain that end, there is something wrong in the mechanical means which are made use of.

Mr. Benjamin Gibbons said, that the only difficulty with the rotatory engine was to keep it tight; but after trying many experiments to overcome that objection, he had never succeeded.

ON A MACHINE FOR PREPARING BONE MANURE.

By W. Buckle, Esq.

The object of this communication is, to endeavour to direct the attention of agriculturists to the usefulness of a machine for preparing bone dust, which has been found to be a most valuable manure. The machine is alike available to improve the nobleman's estate, or the peasant's cottage garden. An ash plant, an iron bar, a pebble from the brook, and a hand sieve, furnishes a bone mill for all that a peasant requires. The arrangement of this machine reduces bones to a state of meal, and thereby prepares it for a rapid change into a state of solubility,—the rapidity of the effects of phosphate of lime on the growth of plants, depending upon its greater or less solubility. In all other mills I have examined, their construction merely provides for crushing the bones into lumps; which, when laid on the land in that state, remain many years undecomposed; producing, meanwhile, little benefit to the crops.

In the year 1833, my attention was directed to this subject, the steward of a large estate in Oxfordshire having requested me to construct a mill to grind bones as fine as could possibly be done; as he found, in practice, that the bones prepared in the usual manner were of little benefit. He also objected to the usual method of boiling the bones before they were crushed by the rollers. I accordingly constructed a mill, which was driven by two horses, and which succeeded so well, that I was requested to increase its power, and to work it by a water-wheel of three-horse power. The first crop of turnips averaged, for each turnip, 47 inches in circumference, and 32½ lbs. in weight, produced from seed of the red round turnip, received from Messrs. Drummond and Son, of the Agricultural Museum in Stirling. They were sown in May, and produced, as above, in October.

In the year 1839, I constructed a bone mill, which was erected on an estate in Surrey. It was driven by a water-wheel, 13 feet in diameter, and 4 feet wide; with additional conveniences to the first one. After a careful course of experiments had been gone through, I received a letter from the proprietor of the estate, of which the following is an extract:—

"I am much obliged by all the attention you have given to my bone mill, with the performance of which I am entirely satisfied; and I hope something may bring you towards London, that I may have an opportunity of showing you how complete a work of the kind I have. Indeed, I know of nothing to compete with it for such a purpose; and the manner of letting the water on to the wheel renders the whole so safe and secure, that I have yet to learn how we could do better. Melville the millwright (who has erected the mill) has prepared himself with experiments in all ways, so as to answer such inquiries as you may make; and being thus fortified, I will not trouble you with any detail, but merely state that we produce 13 bushels of fine dust per hour, and that 17 bushels of fine dust appears to be the product of half a ton of raw bones. Thus we shall be able to produce 136 bushels of dust from 4 tons of raw bones per day of ten hours."

In the mill, or machine, represented in the drawing before the meeting, I have introduced several additions and improvements, which were not in the former ones. The position of the stampers is altered, as dictated by experience; and the elevators are an addition of much usefulness, as by them are lessened the duties of the attendant, whose only care is to admit water on to the wheel, to observe that the store of rough raw bones is ample, and that, generally, the machine is working satisfactorily.

The rough bones are recommended to be heaped together, in a shed adjoining the mill, from whence they should be allowed to slide down the inclined platform into the stamper trough. The middle stamper is recommended to be heavier than the outside ones, to enable it to break the large bones in pieces; those pieces pass on in the trough, from one stamper to another; and, by the time they have reached the outside stamper, they are reduced into meal. The meal then passes into the dressing cylinders, which are placed on a descent, and, by their velocities, force the fine dust or meal through the wires; the coarse dust falls from the end of the cylinders into a box, from which it is raised by the elevators, and descends into the stamper trough, to be crushed fine enough to pass through the wire meshes of the dressing machine. I also recommend the application of elevators for conducting the ground bone dust from the bins, or store, in the cellar, into the waggons, to be by them conveyed to the drill or sowing machinery.

The usual practice of those farmers in Oxfordshire, who use this bone mill, is, to pare as much old turf from the sides of the roads, under the hedges, and other places where they can find it, which, when dry, is burned to ashes. The ashes are then screened and mixed with bone dust, in the proportion of 8 to 10 bushels of bone dust, with from 20 to 100 bushels of burnt ashes, according to the condition of the land they are working. This mixture is put into the front hopper of a drilling machine, constructed as an appendage to the bone mill, and the seed into the second, or break hopper; they are, by this means, both sown at the same time; the raker, or harrow, and brushers at the after part of the machine, following and finishing up the work to be done. Should the season prove favourable, the crop will be abundant. An intelligent and practical farmer informs me, that 12 bushels of bone dust, each 66 lbs., were considered a good dressing for an acre of land, and equal, if not superior, to 12 tons weight of stable or farm yard manure; that the finer the bone dust is prepared, the sooner it will be changed into a liquid state, and only in that state would it, or any other manure, benefit the land; and that bones prepared in the usual way remained unchanged in the land, with little benefit to the crops.

As intimately connected with the subject of my paper, I may perhaps be allowed to allude to the surprising improvements which steam power has effected in agricultural science. To Professor Liebig of Giessen, the Leviathan in Chemistry of the present century, is the world deeply indebted for his deep and valuable researches in art and agriculture. He shows, satisfactorily, that agriculture is both a science and an art: the knowledge of all the conditions of the life of vegetables, the origin of their elements, and the sources of their nourishment, form its scientific basis. From this knowledge, we derive certain rules for the exercise of the art,—the principles upon which the mechanical operations depend,—the usefulness and necessity of these for preparing the soil to support the growth of plants,—and for removing every obnoxious influence. No experience, drawn from the exercise of the art, can be opposed to true scientific principles; because the latter should include all the results of practical operations, and are, in some instances, solely derived from them. Theory must correspond with experience; because, it is nothing more than the reduction of a series of phenomena to their last causes.

The vast improvements which have taken place in Cambridgeshire and the Bedford Level, may be traced to three primary causes:—

Firstly, The improvement in the rivers which pass through the Level; consisting in strengthening their banks, deepening their beds, and, particularly, in improving their outlets to the sea.

Secondly, The substitution of steam-engines for draining, in lieu of the old wind-mills.

Thirdly, The introduction of 'claying,' now universally practised through the Level, where the clay can be obtained.

The several rivers which traverse this Level, from the uplands to the German Ocean, are confined to their channels by banks or mounds on each side, varying in height, according to the elevation or depression of the land they are intended to protect. In times of heavy rain, when a large quantity of water comes from the high lands, those banks are often filled almost to their summit, and the stream flows between them at a height of 10 or 12 feet above the surface of the surrounding country. Originally, those banks were formed entirely of such soil, or earth, as was obtainable in their immediate vicinity; consisting mostly of silt or peat, too porous and too light to resist the pressure of the flood; hence they frequently gave way, and destructive inundations were the consequence. They are now much strengthened and improved by repairing them with better materials,—chiefly gault, carried in boats at much expense and labour. Many miles of them are secured from leakage, by having a wall of puddled gault, sunk 7 or 8 feet deep, along the centre.

At the commencement of this century, the outfalls of those rivers to the sea were in such an obstructed state, from the loose shifting sands brought into them by the tides, and particularly from the wide, flat, and circuitous channels through which they had to flow, that it was impossible, in times of heavy rain in the uplands, to discharge the floods which had to traverse the Level to the sea,—hence, broken banks and inundated districts were of frequent and ruinous occurrence.

To remedy these evils, a cut, or drain, at the lower end of the Ouse, near Lynn, called the Eau Brink Cut, which, after having been in contemplation for centuries, and largely encountering the common lot of all great improvements, from the hostility of ignorance and prejudice, was opened, I think, in 1818. By narrowing the channel, and shortening the course of the river nearly five miles, and avoiding the loose shifting sands which choked the old outfall, this cut, or drain, has proved of immense benefit to the middle and south parts of the Bedford Level. In short, no serious cases of broken banks, or inundation, have happened since its completion.

Great improvements have also been made in the beds of those rivers, by means of the Steam Dredging Engine; which, by removing hard substances, by deepening shallow parts, and by removing other obstructions, so as greatly to increase the scouring effect of the current, has tended very much to the efficient draining and preserving of the Level. The application of the steam-engine to drainage purposes was the second great step in the improvement of the Bedford Level. Under the old system of drainage, by means of wind-mills, it frequently happened that, after a great fall of rain accompanied by high wind, a dead calm of several weeks' continuance would succeed; during which time the mills were entirely useless, and the water often overflowed the land in the interval,—destroying the crop, and rendering its cultivation, particularly with winter grain, a very precarious, and often a ruinous venture.

But thanks to the conceptions of James Watt, and the creations of Soho, our Fen-farmers can now commit the autumnal seed to the ground with as much confi-

dence as their neighbours of the surrounding hills; and can hear the rains rattle against their chamber windows, through the long winter night, undisturbed by a dream of seeing their wheat lands under water in the morning,—a dream which often broke the rest of their fathers, and awoke them to witness its ruinous realities. The wreaths of smoke issuing from the tall chimneys of the Fen-men's steam-engines, like the rainbow to Noah, are hailed by them as a pledge and promise, 'that the waters shall no more become a flood,' to destroy the fruits of their labours and blast their harvest hopes.

The third and crowning step in the scale of improvement was, the introduction of the process of 'claying,' which took place about twenty years ago. It must be understood, that the original surface of the land, from some unknown convulsion of nature, or geological disruption, is at present very different from what it formerly was; as the evidences of its having once been high and dry land abundantly testify in the sylvan remains so frequently found, consisting of fine oak and other trees, the horns of deer, the teeth of wild boars, and bones and relics of other forest animals. Since this era, it must have been overflowed by the sea, as it is covered, in many places to the depth of several feet, with a marine sediment of silt or clay; the deposit exhibiting both those qualities in different places, with all their intermediate mixtures, from the finest warp, of the colour and consistence of mercurial ointment for sheep, to silt, as raw and quick as can be found on the sea-shore at the present day; and all impregnated, more or less, with saline properties, indicative of their marine origin.

The present surface of the Level consists, to the depth of several feet, of a black peat or moor, formed entirely of decomposed vegetable matter, which has accumulated during the course of a long succession of ages, from the abundant aquatic vegetation which grew up and rotted down, year after year, on the surface of the watery waste. This peat is mostly unmixed with the clay above mentioned, over which it forms a distinct superincumbent stratum. From all this, it appears that the sea must have been excluded during the period of its formation. It must also have been partially dry at different eras of its history, as it abounds with the remains of soft-wooded trees, such as willow, alder, birch, &c., which all lie between the clay and the present surface in all stages of decomposition. The peat stratum varies much in depth; in different localities, from two or less, to twelve or more feet, depending in a great measure on the drainage it has undergone since. Where the water is kept out of it by draining, it subsides and loses bulk very fast, rendering it necessary, every few years, to lower the dip of the water-wheels of the windmills or steam-engines employed in draining it.

It will readily be conceived, that a soil so light and porous as this must necessarily, when drained sufficiently for cultivation, require some heavier mixture to render it more compact and adhesive than it naturally is, particularly when exposed by frequent ploughing to the evaporating action of the sun and wind. That desideratum is abundantly supplied in the rich bed of clay underlying it; in most instances at such a depth as to be practically available for this purpose. The process of 'claying,' as it is technically termed, is entirely manual, and may briefly be described as follows:—The land intended to be clayed, after being properly cleaned and prepared, is measured out into parallel 'stetches'—from 12 to 16 yards wide—by a ploughman, who draws a furrow where every clay 'dyke' is intended to be. The 'clayer' commences operations at one end of the furrow, and marks out an oval about 3 feet by 6 feet; and from this space proceeds to dig out the peat, which he casts out *before* him,—continuing to cast out spit after spit, in depth, till he comes to the clay. The clay is thrown out on *each side* in equal heaps, till each heap contains about a cubic yard in quantity: this is the process for the first hole. A space of 2 or 3 feet is left, and the second hole commenced,—the peat out of this hole being thrown *into the first*, and the clay on each side as before,—nothing but the clay being left on the surface. The peat out of each hole being cast into the preceding one, the heaps are spread over the land in the same way as manure, and all the surface as equally covered as can be. The fertilizing effects of 'claying,' on soils previously exhausted, and almost worthless, is astonishing; the produce being frequently from 5 to 6 quarters of wheat, and 10 quarters of oats per acre. It is common to take two or three 'white crops' in succession without any manure, and the land is permanently benefited ever after. The general practice is to clay the land in winter, or early in spring, for oats; after which, the land is sown with wheat in autumn. The land clayed in summer is mostly sown with coleseed, and fed off or ploughed in autumn for wheat; which is not found to succeed so well on clay raised in autumn, as it is supposed to make the land too cold for the young plant in the succeeding winter, should the weather prove severe. The expense of claying, ranges from £2 to £3 10s. per acre.

The introduction of claying has quite revolutionized the agriculture of the Fens. The old course, before the adoption of steam drainage, and other improvements for the security of winter crops, was to pare the surface in May or June, with a plough adapted to that purpose, having a broad share, kept very sharp by the frequent use of the file, to the depth of about two inches: after exposure to the sun for two or three days, the furrows or 'flags' were cast up into heaps, and burned,—the soil being of such a combustible nature, when dry, that it was soon reduced to ashes; and these ashes, when spread over the land, ploughed in and sown with colewort, produced grass on which to feed sheep in the following winter, the land being sown with oats in the following spring. A second crop of oats was sown the succeeding year; and the land 'laid down' with ryegrass for two or three years succeeding; when the same course of burning and cropping was repeated, without any other manure than the ashes, and that left by the sheep which fed off the green crop. When it became practicable, by means of improvements in the drainage, &c., to raise wheat crops, the process was the same. This system was considered the *ne plus ultra* of fen-farming for several years: but it proved a very exhausting process, as the repeated burnings destroyed too much of the staple of the soil; the diminished crops of the ashes became weaker at every repetition of the process; diminished crops of colewort gave less and less animal manure to the land; and the system was fast wearing itself out, when 'claying' came to the poor Fen-man's rescue, and a new era commenced in fen-farming, which has completely superseded the old system, and introduced in its place what can be called no system at all, as there are now no regular courses or rotations of crops. The land is now almost universally under the plough; and when crop-sick with white corn, it is renovated with green crops of colewort, swede turnips, &c., drilled in with *bones*, rape cake, guano, &c.; but chiefly with *bones*, which are used to a great extent.

Mr. Cowper asked Mr. Buckle what was the shape of the stampers? they appeared to be in the form of a cross.—Mr. Buckle replied that the form was that of an inverted cross.—Mr. Cowper: And the weight of the stampers?—Mr. Buckle: The centre one is 4 cwt., the next 3 cwt., and the outside stampers $2\frac{3}{4}$ cwt. each.—Mr. Henry Robinson: What is the height of the stroke of the stampers?—Mr. Buckle: Sixteen inches.—Mr. Cowper: At what speed do they go?—Mr. Buckle: Forty blows per minute. The power is rather under three horse; but the ordinary mills, with rollers, require from fifteen to twenty horses to do the same work. All know, that a very heavily-laden waggon might pass over a leg of mutton bone without having any effect upon it, while a smart stroke from a knife would be sufficient to break it; and I kept that fact in view, in constructing my machine.—Mr. Cowper: Then you mean there is a saving of 80 per cent. from not using rollers?—Mr. Buckle: I do.—Mr. Gibbons: It appears to me, that the principle of this machine is, that the *breaking* force acts by division upon *several points*, instead of concentrating all the power to *crush upon one*, as is done by the roller system.—Mr. Buckle: Precisely so.

ON HIGH-PRESSURE BOILERS, AND ON BOILER EXPLOSIONS.

By W. Smith, Esq.

At the last meeting, I laid before the Institution a tracing and description of the steam boiler which recently exploded near Dudley; and although time did not permit of any discussion as to the merits or demerits of the construction of that boiler, I think it is very evident that boilers of similar formation and dimensions cannot be safely used for high-pressure steam,—say 40 to 50 lb. per square inch. I make this assertion, because the great diameter of the outer shell renders it very liable to be torn asunder by the internal pressure; the internal vertical flue being also of such dimensions that it may be forced out of form, and suddenly collapsed by external pressure; and if that system of boiler were to be made safe by a large reduction of the diameter, it would make them insignificant in capacity of heating surface and generating power, and consequently unfit for their intended purpose,—namely, to use the great quantity of heat which escapes from puddling furnaces.

I have prepared the accompanying drawing of a boiler which I recommend, in preference to those on the above principle; being much better adapted for generating, and for safely containing high-pressure steam; and I think more convenient, in every other respect, for the above system of heating.

The boiler is 32 feet long, and 4 feet 9 inches in diameter; with two tubes, or flue pipes, under it,—each 36 feet long, and 1 foot 8 inches in diameter, and attached to the boiler by three vertical pipes, 10 inches in diameter. The flue pipes are made in a bent form, so as to be highest at the middle, and drooping to each end, to keep circulation in the water.

Firstly, The diameters of the cylinders being small, they may be made of much thinner plates, and still be perfectly safe with a greater pressure of steam.

Secondly, The heating surface is large and concentrated, without winding flues, so that much steam will be generated.

Thirdly, The area of water surface being much larger, there will be less difficulty in maintaining its proper level.

Fourthly, The steam and water space, and heating surface, harmonize in their proportions.

Fifthly, The great facility for cleaning out. This is an object of the first importance in the construction of all kinds of steam boilers,—as it is well known, that where any difficulty exists in performing that operation, the chances are, that it will either be imperfectly done, or left undone altogether; which is one cause of many of the fatal explosions that so frequently happen with land boilers.

I do not wish to enter at any length on the theory of explosions; but merely to state my conviction, that to one of the three following causes are to be attributed all the accidents to steam boilers:—

First, Malformation for the working pressure, and quantity of vapour required.

Second, Want of proper care to fit every boiler with proper steam and water indicators; and,

Third, Neglect of cleaning out at proper times.

It is a lamentable fact, that many boilers, extremely liable to accident from one or other of the above-named causes, are still in use; and I think the following reasons will, to a great extent, account for so bad a state of things existing; in a country, too, where so much engineering skill may always be procured to rectify defects:—

Respecting malformation, I would state, that parties about to make erections for steam power, generally make the first outlay of capital a leading consideration; and, consequently, cramp the dimensions of their engines,—so that the engines are just calculated to do the work required, with nothing to spare. Soon, however, some extra machinery is introduced into the establishment; and the engine being found defective in power with the original pressure, an extra load is immediately put upon the safety-valves of the boiler; and this process is repeated, time after time, as each little additional machine may require the extra power. It follows, that the boilers which were prudently arranged to do the work in the first instance, are, at last, a malformation for the increased pressure, and therefore work in a

highly dangerous state; whilst the unsuspecting operatives may be seen crowding round to warm themselves at meal times, when the danger is probably greatest.

Then as to defective steam and water indicators, I have always observed that land engine boilers are not so efficiently fitted with these instruments of safety, as marine and locomotive boilers: although I think it very necessary that they should be so, seeing that a number of them are frequently left to the charge of one individual, with other duties requiring much of his time and attention; whereas, the indicators of marine and locomotive boilers are constantly under the eyes of one or more engineers of well-proved character and ability for the duties required; and, moreover, engineers of a higher class are always resident at the principal stations, invested with power to examine engines, and to inspect the whole machinery periodically.

I have shown, on the accompanying drawing, all the indicators which I consider necessary for a high-pressure boiler in ordinary circumstances. They are as follow: one feed cock or valve; one float water guage, with stand and wheel, and counterbalance; one glass water guage; one steam whistle, also for a water guage; and two safety valves, one of them locked up.

For low-pressure boilers, I think the open top feed pipe, with open pipe for the float wire to work through, is a very perfect apparatus to prevent the steam from rising too high, or the water from getting too low.

Respecting the keeping of boilers clean, I have seen that process very imperfectly performed, and often altogether neglected, in establishments where a sufficient number of spare boilers are not provided, and where there is no time to have the boiler cooled down for men to remain in it to do the work properly; but I believe that the greatest cause of neglect in this most important matter is, its being generally looked upon as a thankless sort of job; the engine-man always looking upon it as an extra duty, for which he claims extra allowance; and the master considering that he pays enough to the engine-man for that and his other duties.

The results consequent upon inattention to boiler cleaning requires no comment here; and every practical engineer knows, that if actual explosion does not happen, the tear and wear upon those parts most exposed to the fire must be greatly increased, thereby keeping up a heavy expense in repairs, independent of the immense quantity of extra fuel that is required to keep up the steam.

I trust that these remarks will suffice to draw the attention of the members of the Institution to this highly important subject, and that the proprietors of steam power may be convinced, that the small extra outlay required to make their boilers perfectly safe, will be more than repaid by the economy in working.

Mr. Henry Smith said, that one disadvantage of the plan proposed was, the large amount of room which the boiler would occupy; and that space was often a great object to gain in works.—Mr. Gibbons thought that less space would be occupied than formerly.—Mr. Smith observed in reply, that, on an investigation, the objection would be found not to apply to his boiler, which had something in its favour as to size, over the ordinary boiler, though not much.

Mr. Buckle remarked, that he had had frequent opportunities of observing the reckless manner in which the fitting up of engine boilers is carried on in Staffordshire; to which, however, there were some exceptions. The upper part of them is generally exposed to the weather, a system which, in most cases, is attended with ruinous loss. He thought that it would tend greatly to lessen the number of those fearful boiler explosions which had so quickly followed each other of late, and would also be the means of effecting a great saving to the proprietors of the numerous iron-works in Staffordshire and other districts, if a superintending engineer, who thoroughly understood his profession, were appointed to examine, periodically, the condition of the engines and boilers employed in these works. It was to him perfectly astonishing, that such immense ranges of boilers should be left completely exposed to the weather, as was often the case. In the year 1832, he was sent for to Bilston, to superintend the renovation of an old blast engine: he had satisfactorily completed the undertaking, when, the season being that of harvest, a thunder storm, accompanied by tremendous rain, came on; and when he was expecting that everything was right, the engine completely stopped. He thereupon tried the safety valves of the boiler, but not a breath of steam came from them. The steam had become condensed by the exposure of the boiler to the storm; and no excuse could be offered for such gross neglect, as materials for covering were to be had quite at hand, and would cost but little. He believed that a handsome fortune might be made by covering up the boilers.

Mr. Fothergill inquired of Mr. Smith, whether his boiler was not what is termed a "French boiler?"—Mr. Smith replied that it was; he had made them in France.—Mr. Fothergill: Are they not apt to crack on the upper surface of the lower tube, and, on that account, subject to frequent complaints?—Mr. Smith: They never have cracked to my knowledge.—Mr. Fothergill thought that there would be a tendency to crack in the upper surface of the lower tube; and also, that greater wear and tear would be occasioned by the exposure of the lower tube to a greater amount of heat, and the action of the fire, than the upper one.—Mr. Smith did not think that the tube would be liable to such an injury; because the circulation of water was kept up.—Mr. Cowper suggested the lengthening of the tube, on the principle of lengthening a chimney to get a better draught.—Mr. Smith considered that such an alteration might be an advantage.—Mr. Cowper remarked that, as a protection from the white heat of a blast furnace, there ought to be a parapet wall. He thought that the boiler would be far preferable if parts of it were covered with brick-work.—Mr. Smith said, that the operation of the heat on the tube was common to other descriptions of boiler in blast furnaces; and that the operation was not greater in his than in any other case.—Mr. M'Connell thought that there should be an indicator, to enable the man who attends to the boiler to ascertain when the circulation between the lower and upper tube is impeded. It appeared to him that there was reason to fear that the lower tube might be deprived of water.—Mr. Smith had never seen or heard of such a thing having occurred; neither did he see that it was likely, or possible. If the boiler was half filled with water, the tubes were of such dimensions, being ten inches in diameter, that he did not see how any part could get clear of water.

Mr. M'Connell: That accident had actually occurred at the salt-works at Droitwich: the lower vessels, from a want of circulation, were deprived of water, and an explosion took place. In that case there were greater facilities for the circulation of water than those allowed by Mr. Smith. The cause of the accident was, the lower vessel being deprived of water, and the consequent rapid generation of steam. Fortunately, at the moment of the explosion the men were at dinner; but had it happened only five minutes before, fifty or sixty persons would have been killed; as it was, three or four only suffered. If Mr. Smith's boiler were brought into general use, some detector apparatus should be employed, to ascertain whether the upper vessel was doing its duty by circulating the water to the other one.—Mr. Ramsbottom was of opinion, that an improvement would be effected in the boiler, by making the generating cylinders lowest in the middle, and inverting the direction of the circulation, by having the descending current in the centre tube. The greater part of the steam which is generated near the ends of the lower cylinders, would not then have to pass along into the centre tube, but would find its way immediately, through the end tubes, into the steam chamber; the circulation would, therefore, be much more rapid.—Mr. Smith said, that he felt gratified by the various suggestions that had been made. They would induce him to turn his attention to the means of improving the boiler brought before the meeting; but he trusted they were all of opinion, that it was infinitely better adapted for its purpose than those now in use.—Mr. Robinson said, he should like to know whether, in any case, heat would injure boiler plates where there was a constant supply of water?—Mr. Cowper said, he could take upon himself, from experience, to answer the question in the affirmative.

Mr. Fothergill said, he would take leave to exhibit the drawing of a boiler which had recently exploded in Manchester—sacrificing thirteen or fourteen lives. The boiler showed such singular rents, that he had been induced to have a drawing of it made by an artist; and he had purchased the boiler, and presented it to the Manchester Mechanics' Institution. The drawing clearly showed the consequences of that kind of boiler getting out of repair; and he considered that the observations of Mr. Smith were most important. Every member would be satisfied, that if the sacrifice of life on the explosion of a small boiler, such as he had referred to, was so serious, the result of the explosion of one of a larger class, carrying a greater pressure, must be fearful indeed, unless proper attention were paid to the protection of the lives of the men who have to attend to them. He was collecting particulars respecting the explosion of the boiler to which he referred; and he intended to lay them before the Institution at some future meeting.

Mr. Gibbons said that, in the cases which had been referred to, the explosions would have been guarded against by a simple indicator like the following:—A gas pipe, of any diameter, inserted through the top of the boiler, down to a safety line in the water,—to be acted upon by hydrostatic pressure, so as to show the pressure of the steam, and also, any deficiency of water in the boiler; these being the two causes from which explosions of high-pressure boilers principally arise. This indicator may be of any diameter (say 1½ inches); to be open at both ends, affixed to the engine chimney, and lengthened upwards to whatever height the pressure of the steam in the boiler may require,—calculating two feet of perpendicular height for every pound of steam power. Suppose the water to get below the safety line, the steam would rush out at the top of the pipe; or, suppose the safety valve to be overloaded, or not to act, the water would be ejected at the top—thus giving an instantaneous alarm to the engineer and workmen. The cost of the whole thing would be very trifling; it could easily be applied, and would not be liable to get out of order.

The President remarked, that the suggestion of Mr. Gibbons was not new, for such a pipe had long been known as the alarm pipe.—Mr. Gibbons considered it was desirable that its utility should be more generally known.

ON A STATION AND COLLISION BREAK APPARATUS.

By C. De Bergue, Esq.

The subject to which this paper refers, is an improved apparatus, intended to act as a station buffer or break, for arresting the impetus of any engine or train that may have entered a station at too great a velocity. It is also proposed to apply the same to luggage vans accompanying trains, in order to lessen the injurious effects of collisions on railways; but, first, it will be more particularly referred to as a station buffer.

To render a station buffer as effectual as possible, it should combine the four following conditions:—

Firstly, It should move through as much space as, in the arrangement of the machine, is consistent with moderate proportions and economy.

Secondly, Its power of resistance at the commencement of the stroke, should be rather under the average amount that will drive home the ordinary carriage buffers; say about three tons.

Thirdly, Its resisting power should be made to increase gradually through the whole range of action, so that, before the stroke is quite completed, the resisting force should be nearly as much as the under frames of the carriages would be able to bear without breaking or collapsing,—probably from 12 to 16 tons.

Fourthly, It must not have any recoil action after being driven up.

Supposing a train, with a momentum equal to 100 tons, moving through one foot of space, to come in contact with a station buffer, it would be requisite, to enable the station buffer to arrest the impetus of the train, that the resisting power and the length of the stroke should be in proportion to each other.

A station buffer having but one foot of action, would require a resisting power of

100 tons to arrest the above train; but in this case the carriages would be smashed by the collision; yet if the station buffer was made to move through a space of 10 feet, then a uniform resistance of 10 tons would suffice to arrest the train; but although, in this case, a resisting power of 10 tons at the commencement, and throughout the stroke, might not actually cause the carriages to be smashed, the passengers would receive so severe a concussion that the consequences might be equally disastrous.

If the resisting power was made to commence at 3 tons, and was kept progressing in such a ratio throughout the 10 feet, without exceeding 16 tons at the end, so that the average resistance would still be equal to 10 tons moving through 10 feet, the train would then be brought up without sustaining any damage. This would be the maximum useful effect that could, under any circumstances, be produced by a station buffer having a 10-feet stroke, with a resistance ranging between 3 and 16 tons. The resisting power of such a buffer would be equal to 1 ton through a space of 100 feet, or to 100 tons through 1 foot; and its power may be increased or reduced, by increasing or reducing the length of stroke. This is the result which has been sought to be obtained by arranging this buffing apparatus, a working model of which is now before the meeting. It is made to a scale of one-eighth of full size; its power and weight is as the cube, or as 1-512.

It represents a strong under-frame of a railway carriage, supported, as is customary, on wheels and axles. The buffer rods are in the usual position, but are much longer, and larger in diameter. They are intended to be made of welded wrought-iron tubes, 3½ inches in diameter, for obtaining strength without too much weight. They stand out 4 feet at each end of the carriage, and terminate inside in wrought-iron racks, the teeth of which are cut out of the solid. These racks must be made of a suitable breadth, and with a pitch of sufficient strength, to resist the maximum power they are intended to sustain. The racks of one end of the carriage are turned with their teeth upwards, and those of the other end with their teeth downwards, and are placed so as to admit the passage between them of the pinions which gear simultaneously into the two racks. A strong wrought-iron transverse shaft, or axle, passes directly across the centre of the carriage, being fitted in bearings in the side beams. On each end of this shaft a wrought-iron pinion is formed, which should be forged therewith in one piece, the teeth being afterwards cut out of the solid, in order to render them sufficiently strong for the purpose.

A friction drum is securely keyed on the centre of this shaft; this drum is surrounded by two steel friction belts, which take about a turn and a quarter round it, being made fast at one end to one of the cross stays, while the other ends are attached to the vertical arms of two levers, the other ends of these levers being subject to depression by the action of two small springs, which are so arranged that, when the apparatus is put in motion, the pressure on the ends of the levers increases in proportion as the buffer rods are required to oppose greater resistance. As the model will be readily understood by the members of this meeting, it will be useless to give a minute and tedious description of it; a few general observations will therefore suffice.

It will be observed, that the principal feature of this invention consists in producing the resisting power of the buffers by means of a friction break, so combined as to effect an increasing amount of resistance throughout the range of the stroke; and that, as this resisting power is effected by mechanical means, it is susceptible of being modified almost to any extent, as regards its length of stroke and amount of resistance, during its range of action; and that it possesses the great advantage of having no recoil. The model before the meeting is intended, as the under-frame of a luggage van, to be placed between the back of a tender and the carriages composing a passenger train, or at the back of a train on foggy nights, in the event of another train running into it. This model represents eight feet of stroke for the buffers; supposing the resisting power to average only 10 tons, it would be equal to destroy a momentum of 1 ton through 80 feet, or 80 tons through 1 foot.

This would be a considerably more effective buffer than any station buffer now in use.

It may be presumed, that, if a good and powerful buffer could be of any use in a station, this apparatus must be of some service in a train in the event of a collision; especially when it happens, as it frequently has done, that the speed of the train has been very considerably reduced before the collision actually takes place.

It is intended to make several modifications in the model for its special application as a station break, and, particularly, to give it more length of action.

SOCIETY OF ARTS.

The prize list of this father of societies, for 1848-9, has just been issued, and exhibits a systematized classification far superior to any of former years. There are no less than four distinct classes of prizes for objects coming within the nomenclature of decorative art:—1. For students. 2. Medals and money rewards for matured artists producing decorative designs worthy of the society's sanction. 3. Medals and honorary rewards to artizans and workmen. 4. Medals and honorary testimonials to manufacturers producing beautiful works.

In the first, or studeuts' class, 12 prizes are offered. The second, or designers' class, numbers 26. In the third, which more particularly concerns ourselves and our readers—the artizans' class—7 prizes are to be bestowed for good examples of workmanship. That for the best specimen of wood-carving, the production of an artizan not a wood-carver by profession, is understood to have been suggested by Prince Albert, with the laudable intention of promoting an agreeable home occupation as an auxiliary to other labour. In the fourth, or manufacturers' class, no limitation of prizes is mentioned.

In the section of agriculture there are 9, and in chemistry, 11 prizes: in mechanics, 9, and in the colonies and trade, 14. The selection bears evidence of having been drawn up by practical men, who see the true direction of future improvement.

As president of the society, Prince Albert has been of material assistance in furthering its practical works; and we find that he has offered a gold medal for the best account of any new and improved machinery, or processes, employed in the cultivation or preparation of sugar in the British colonies; also, a gold medal for the best cement for uniting glass, particular attention being made to perfectly cementing glass pipes and glass roofing.

THE METEOROLOGICAL SOCIETY OF LONDON.

This is an addition of some importance to our catalogue of scientific societies. We gather from its prospectus, that its objects are to spread a knowledge of meteorology, and to obtain information as to the causes which operate in producing changes and modifications in the condition of the atmosphere. It is proposed that the society shall be governed by a president, three vice-presidents, and a council of seven, which appointments were made at a meeting held on the 10th ult.

The members of the council pledge themselves to use their scientific knowledge for the benefit of the agricultural and shipping interests, for which end there can be no doubt as to the value of their researches, if properly carried out. In the present state of the society, we can do nothing more than chronicle its existence. We may mention, that W. H. White, Esq., M.B.S, 33 Albany Road, Camberwell, is the secretary *pro tem.*, and that the subscription constituting membership is one guinea.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—EIGHTEENTH MEETING.—SWANSEA, AUG. 9.

The eighteenth annual meeting of this society was nominally commenced on the 9th ult., by a gathering at the Royal Institution, to hear the report of the council, the general treasurer's account, and to appoint officers for the several sections—Sir R. H. Inglis in the chair. The council reported to the general committee, that the Board of Admiralty will appropriate a suitable vessel for the purpose of an investigation into the phenomena of the tides, as soon as the most advisable plan for her employment shall have been determined upon. The East India Company have also issued orders for carrying into regular operation the tide observations on the coasts of Western India and Scinde, and have placed the standard bar and scale of the Indian arc of the meridian at the disposal of Professor Struve, permission having been given to him to take it to Russia, for comparison with the similar instruments employed in the measurement of the Russian arc of the meridian.

The following names have been added to the list of corresponding members:—Professor Struve of St. Petershurgh; M. Leverrier of Paris; Charles Bonaparte, Prince of Canino; the Chevalier Bunsen; Professor Nilsson of Sweden; Professor Esmark of Christiana; Dr. Vander Höven of Leyden; Dr. J. Milne Edwards of Paris.

The order of the proceedings has this year been slightly varied, and some change has been made in the disposition of the sections. Section E, formerly devoted to physiology, has been united with botany and zoology, to form section D; and ethnology, now constituted a subsection of the new member, remains attached to the same section. The actual business of the meeting commenced on the 10th ult., by the reading of papers and discussions thereon; and in the evening of that day, Dr. Percy lectured on the smelting of iron, in the Baptist Chapel. On the 11th, all the sections, except the ethnological, met again. On the 12th, there was no meeting, and a large party paid a visit to the iron-works of Ystalyfera, and witnessed the results of Mr. Budd's improvements. The bone caves and cliffs of Gower attracted the attention of another party; and a dredging excursion in the Bristol Channel formed an occupation for a third. Some botanists, headed by Mr. Babington, rounded the coast from Oystermouth to Penard Castle, where they obtained specimens of the rare plants of the locality. On Monday the 14th, the sections met again. In the evening, Dr. Carpenter lectured on microscopic structures. Tuesday and Wednesday concluded the business of the sections, and finished the meeting.

Dr. Percy's lecture "On the Chemistry of the various Metallurgic Processes now practised round Swansea," was chiefly directed to copper smelting. The varieties of ores employed, the oxide of copper, the sulphuret and the double sulphuret of copper and iron, and the recently imported carbonets, were minutely described; as also the process of roasting to expel the arsenic, and, to some extent, the sulphur. The advantages of the recently discovered process of Mr. Napier, in which the ore is reduced by taking advantage of the chemical affinity of iron for the sulphur of the ores, were fully detailed; and notice was taken of the works at Ystalyfera, where anthracite is employed for fusing iron, and the heated gases, escaping at the top of the furnace, are collected and employed to heat the boiler of the steam-engine.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

President—Lord WROTTESLEY.

Vice-Presidents—The DEAN OF ELY, Rev. Dr. WHEWELL, Lord ADARE, Sir D. BREWSTER.

Secretaries—Dr. STEVELLY, Mr. G. G. STOKES.

Committee—Professor Plücker, Dr. Siljestrom, Captain Sir E. Belcher, Professor D. Gray, Dr. Greene, Sir W. S. Harris, Professor Hodgkinson, Mr. W. Lassel, Dr. Lee, Dr. Lloyd, Professor Phillips, Colonel Portlock, Messrs. F. Ronalds, J. Scott Russell, Colonel Sabine, Colonel Sykes, Professor Wheatstone.

"On the Effect of the Rapid Motion of the Observer on Sound," by Mr. Scott Russell.—Until the existence of the very high velocities now given to railway trains, no opportunities have existed of observing any phenomena in which the velocity of the observer has been sufficient to affect the character of sounds. The author having had occasion to make observations on railway trains moving at high velocities, has been led to notice some very curious effects in sounds heard at 50 and 60 miles

an hour. These effects are not heard by an observer who is stationary. He found that the sound of a whistle on an engine stationary on the line was heard by a passenger in a rapid train to give a different note—in a different key from that in which it was heard by the person standing beside it. The same was true of all sounds. The passenger in rapid motion heard them in a different key, which might be either louder or lower in pitch than the true or stationary sound. The explanation of this was given as follows:—The pitch of a musical sound is determined by the number of vibrations which reach the ear in a second of time—32 vibrations per second of an organ pipe give the note c, and a greater or less number give a more acute sound or one more grave. These vibrations move with a velocity of 1024 feet per second nearly. If an observer in a railway train move at the rate of 50 miles an hour towards a sounding body, he will meet a greater number of undulations in a second of time than if at rest, in the proportion which his velocity bears to the velocity of sound; but if he move away from the sounding body, he will meet a smaller number in that proportion. In the former case, he will hear the sound a semitone higher, and in the latter a semitone lower, than the observer at rest. In the case of two trains meeting at this velocity, the one containing the sounding body and the other the observer, the effect is doubled in amount. Before the trains meet, the sound is heard two semitones too high, and after they pass two semitones too low—being a difference of a major third. There were next explained the various effects which the noises of a train produced on the ears of passengers at high velocities. The reflected sounds of a train, from surfaces like those of bridges across the line, were at ordinary velocities sent back to the ear changed by less than a semitone, so as to cause a harsh discord, which was an element of the unpleasant effect on the ear when passing a bridge. In a tunnel, also, the sounds reflected from any irregularities in the front of the train, or behind it, were discords to the sounds of the train heard directly. He showed, however, that at a speed of 112 miles an hour, these sounds might be those of a harmony with each other, and become agreeable, for the sounds reflected in opposite directions would have the interval of a major third.

Sir D. Brewster observed, that in his opinion the explanation of the curious effect of rapid motion of the observer on sound was to be sought from physiological causes, and not accoustic: and pointed out what he considered to be analogous phenomena with respect to light—such as the augmentation of light at the boundary of moving shadows, the perfect clearness with which objects could be seen through rapidly moving openings in screens, and the production of colour by screens in motion under certain circumstances.

Sir W. S. Harris conceived that all the effects were to be explained by the undulatory theory of sound, in the manner in which they were explained by Mr. Scott Russell.

"On some New Relations of the Diamagnetic Force," by Professor Plücker.—Mr. Plücker gave a short account of experiments belonging to a new magnetic action. A crystal with one optical axis being brought between the two poles of a magnet, there will be a repulsive force, going out from each of the poles, and acting upon the optical axis. According to this action, the crystal, if suspended, will take such a position that its optical axis is placed within the equatorial plane. When the crystal has two optical axes, there will be the same action on both; according to which, the line bisecting the acute angle formed by the axis will turn into the equatorial plane. When the crystal is suspended in such a way that it may freely move round any line whatever of the plane, containing both axes, this plane will take the equatorial position. Thus, a crystal being neither transparent nor showing any trace of its crystaline structure, we may, by means of a magnet, find the optical axes. At the same time we get a new proof of the connection between light and magnetism. When light is passing through a crystal, there are in general two directions, where it is effected in a quite distinct way—these same directions are acted upon by a magnet.

Professor Faraday contrived to convert two raw potatoes into representatives of the poles of an electro-magnet, and by a slice of another, with a quill stuck through it, represented the magnetic or diamagnetic crystal with its optic axes—and thus contrived to convey a distinct idea of the exact results of Professor Plücker's discoveries of the relations of the optical axes of magnetic and diamagnetic crystals, and the changes of distance to the nature and laws of the attractions and repulsions exhibited under the several circumstances detailed.

Sir W. S. Harris considered that the laws of magnetic forces in relation to the action of magnets on each other, or a magnet on a mass of common iron, were liable to vary, from the changes which arose in the amount of inductive action of which the attractive bodies were susceptible. He had shown, in a paper in the *Edinburgh and London Philosophical Transactions*, that in electricity and magnetism, the amount of inductive disturbance was limited—so that, after a certain time, under given conditions, the disturbance became the greatest possible, and then the law of the force changed; and hence arose all the irregularities which had embarrassed early inquirers into this subject. In fact, the force between a magnet and a simple mass of iron varied in a simple inverse ratio with the force induced in the iron and with the disturbance conjointly. If either of them became constant, the whole force varied with the other. If, therefore, it should happen that as the disturbance in the iron approached a limit, the changes were not uniform, then we obtained irregular results. So long, however, as the induced force went on uniformly, we had the total or absolute force in the inverse ratio of the squares of the distances. In the case of two magnets magnetized, or nearly so, the force of attraction between them varied in the inverse ratio of the simple disturbance, because the amount of the induced force had been reached. On this principle, it was found that in the repulsive force between two magnets, the repulsive action at certain distances became changed into attraction; and it is not an uncommon circumstance to find two magnets attract at one distance and repel at another. These results, he thought, might be applied in explanation of some of the phenomena now under consideration. The force of magnetic action might vary, whilst the diamagnetic force, after all, may have been constant.

Dr. Lloyd inquired if Professor Plücker had tried whether crystals with positive axes, exhibited any difference in the laws of diamagnetic action from those which had negative axes?

Professor Faraday replied, that Professor Plücker had minutely investigated this point, and found no diversity of law corresponding to this difference in optical structure.

Sir D. Brewster inquired whether Professor Plücker had investigated the influence which changes of temperature produced in the diamagnetic action of crystals? Some of these changes, he conceived, were of such a nature as to afford an admirable test whether the same circumstances in the corpuscular constitution of the crystal on which their optical characters depended, were those which gave rise to their diamagnetic relations or not. For example, in some of the biaxal crystals, as sulphate of lime, when heated, the axes approached, and at length coincided—the crystal becoming monaxal; and by continuing the heating, they again separated in a plane at right angles to the one in which they before lay. Such a series of changes, he conceived, if examined in relation to the diamagnetic forces, might afford a test whether the curious properties discovered by Professor Plücker had their origin in the chemical constitution of the bodies, or in that corpuscular structure from which their optical properties originated.

Professor Plücker replied, that he had not tried the class of experiments pointed out by Sir D. Brewster; but he admitted their importance, and expressed a determination to pursue the inquiry.

Professor Grove inquired whether the experiments were tried with the crystals placed in vacuo?

Professor Plücker replied no; but in every case they were suspended either in air or water.

Professor Grove pointed out the necessity of caution in that case, as it was well known that differences between the diamagnetic actions of suspended bodies and of the surrounding medium would sometimes mask and even reverse the action.

Professor Faraday pointed out the precautions which had been taken to avoid this source of error.

"On the Visual Impression upon the Foramen Centrale of the Retina," by Sir D. Brewster.—The author described by diagrams the position of the optic nerve as it enters the eye; which, though covered by the nervous coat of the retina, is entirely devoid of the choroides; and it is well known that if the image of even a bright object, as of a candle, be made to fall on this spot, nothing but an indistinct luminosity can be perceived. Sömmering was the first who observed exactly, at the place where the optic axis reaches the retina, a spot at which, while the choroides were there perfect, the retina was entirely absent; yet it was on this spot that the image was formed when the vision was most distinct—for it was well known that when we wanted to see things most accurately, the optic axis of both eyes were directed upon it. This spot, therefore, which was called by its discoverer the foramen centrale, had at all times occupied much attention; but it was found very difficult to determine its extent, or even its form—chiefly because in the dead human eye it was found to be a mere fold, as some maintained, or two folds across, as others. The author—having observed that after the eye had been for some time reposed, if it be turned to a uniformly and not too strongly illuminated surface, such as a sheet of white paper held at some distance, a dark round spot was perceived surrounded by the uniform white of the ground—said, that this spot in some peculiar states of disease was found to be a bright spot surrounded by a dark ground. On considering this spot, he found its place to correspond with that of the foramen centrale; and having accurately measured its angular magnitude, he found it to be about 35′ of a degree; which, assuming the eye-ball to be a sphere of about five-tenths of an inch diameter, would give the diameter of the spot about the one-thirtieth of an inch—which he believed was pretty nearly that assigned originally to the foramen centrale by Sömmering.

"On the Vision of Distances as given by Colours," by Sir D. Brewster.

"On a Difficulty in the Theory of Light," by G. G. Stokes, Esq.

"On the Perfect Blackness of the Centre of Newton's Rings," by G. G. Stokes, Esq.—The absence of all reflected light at the centre of Newton's rings, when formed between two lenses of the same substance, was explained long ago by Fresnel, by the aid of a law discovered experimentally by M. Arago, that light is reflected in the same proportion at the first and second surfaces of a transparent plate bounded by parallel surfaces. It occurred to the author that this law may be called the *principle of reversion*. By this is meant the general dynamical principle, that if in any material system in which the forces depend only on the positions of the particles the velocity of each particle be suddenly reversed, the previous motion will be repeated in the reverse direction. It follows from this principle, that in the case of a series of waves of light incident on the surface of an ordinary medium, and producing a series of reflected and a series of refracted waves—if the vibrations in the reflected and refracted series be reversed, the incident series will be produced only in a reverse direction. But the reflected and refracted series, when reversed, would each produce a series of reflected and a series of refracted waves; and it follows, from the principle of superposition, that of these four series the two which are situate within the medium must neutralize each other, and the two which are situated outside of the medium must together produce the incident series reversed. The two equations are thus obtained, whereby the perfect blackness of the centre of Newton's rings is explained. These equations are those which are written in Airy's Tract, $b = -c, cf = 1 - e^2$. The detail of this method will soon appear in the "Cambridge and Dublin Mathematical Journal."

Our present limits do not allow of a further detail; next month we shall enter upon a review of the leading papers.

ENGLISH PATENTS.

Sealed from 20th July, 1848, to 17th August, 1848.

Chevalier Alexandre Edward Le Molt, Conduit-street, Middlesex,—"Certain improvements in apparatus for lighting by electricity, parts of which may be made use of in other applications of electricity."—July 20th.

David Napier and James Murdoch Napier, York-road, Lambeth, engineers,—"Improvements in mariners' compasses, also in barometers, and in certain other measuring instruments."—20th.

William Thomas, Cheapside, merchant,—"Improvements in the manufacture of stays, boots, and shoes, also in fastening and connecting fabrics and garments."—26th.

John King, foreman to Messrs. Shears and Sons, Bankside, and Henry Medhurst, operative engineer to the said Messrs. Shears and Sons,—"Improvements in gas meters."—26th.

Charles Hancock, Brompton, Middlesex, gentleman,—"Improvements in apparatus and machinery for giving shape and configuration to plastic substances."—29th.

John Grist, New North-road, Middlesex, engineer,—"Improvements in furnaces and fire-places."—29th.

James Robertson, Great Howard-street, Liverpool, cooper,—"Improvements in the manufacture of easks and other wooden vessels, and in machinery for cutting wood for those purposes."—29th.

George Walter Pratt, City of Rochester, State of New York, United States, America, gentleman,—"Improvements in the manufacture of printing ink."—29th.

Richard Abbey, Slough, Buckingham, brewer,—"Improvements in preserving fermented and other liquids and matters in vessels."—29th.

Edward Gribben Wilson, Bury, Lancashire, tin-plate worker,—"Certain improvements in the construction of tin drums or rollers used in the machinery for drawing, spinning, doubling, twisting, and throwing cotton, wool, silk, flax, and other fibrous substances."—29th.

Duncan Mackenzie, Goodman's Fields, manufacturer,—"Certain improvements in Jacquard machinery for figuring fabrics and tissues generally, and apparatus for transmission of designs to said Jacquard machinery, parts of which are applicable to playing musical instruments, composing printing types, and other like purposes."—(Communication.)—August 5th.

David Newton, Macclesfield, Cheshire, merchant,—"Certain improvements in the application of glass and glazed surfaces to nautical, architectural, and other similar purposes."—7th.

Samuel Thornton, Birmingham, merchant, and James Edward M'Connell, Wolverton, Buckinghamshire, engineer,—"Improvements in steam-engines, and in the means of retarding engines and carriages on railways, and in connecting railway carriages or waggons together; also improvements in effecting a communication between one part of a railway train and another, by signals or otherwise."—7th.

John Metcalfe, Little Bolton, Lancashire, machine-maker, and Robert Halliwell, of the same place, mechanic,—"Certain machinery or apparatus for preparing and spinning cotton and other fibrous substances."—8th.

Moses Poole, London, gentleman,—"Improvements in the manufacture of casks and other similar vessels of wood."—(Communication.)—8th.

Samuel Lees, of the firm of Hannah Lees and Sons, Park Bridge, Lancashire, iron manufacturer,—"Certain improvements in the manufacture of malleable iron."—8th.

Joshua Cooch, Harleston, Northamptonshire, agricultural implement maker,—"Improvements in sackholders."—10th.

William Thomas Henley, Clerkenwell, philosophical instrument maker, and David George Foster, Clerkenwell, aforesaid, metal merchant,—"Certain improvements in telegraphic communication, and in apparatus connected therewith, parts of which improvements are also applicable to the moving of other machines and machinery."—10th.

Samuel George Hewitt, Buchanan-street, Glasgow, engineer,—"Improvements in the construction of certain parts of railways."—11th.

John Varley, Bury, Lancashire, engineer,—"Certain improvements in steam-engines."—14th.

James Henderson, Surrey Canal Dock, millwright,—"Improvements in machinery for cleansing and polishing rice, pearl barley, and other grain and seed."—14th.

Joseph Simpson, Manchester, civil engineer, and James Alfred Shipton, of the same place, engineer,—"Certain improvements in steam-engines."—14th.

Edwin Thomas Truman, 40 Haymarket, London, dentist,—"An improved method or methods of constructing and fixing artificial teeth and gums, and of supplying deficiencies in the mouth."—15th.

Thomas Warren, Montague-terrace, Mile-end-road, Middlesex, gentleman, and Willoughby Theobald Monzani, James-terrace, Blue Anchor-road, Bermondsey, Surrey, gentleman,—"Improvements in the construction of bridges, aqueducts, and roofing."—15th.

Thomas de la Rue, Bunhill-row, Middlesex, manufacturer,—"Improvements in producing ornamental surfaces to paper and other substances."—15th.

William Galloway and John Galloway, Knott Hill Ironworks, Hulme, Manchester,—"Certain improvements in steam-engines."—17th.

Moses Haym Picciotto, Finsbury-square, London,—"A method or methods of purifying and discolourizing certain gums."—17th.

SCOTCH PATENTS.

Sealed from 26th July, 1848, to 21st August, 1848.

James Napier, Shacklewell-lane, Middlesex, operative chemist,—"Improvements in smelting copper and other ores."—July 26th.

John Miller, Henrietta-street, Covent-garden, London, gentleman,—"A new system of accelerated menattrite locomotion, even by animal impulsion, for every species of transport machines, acting by means of wheels, whether on land or water."—(Communication.)—27th.

George Emmott, Oldham, Lancashire, civil engineer,—"Certain improvements in the manufacture of fuel, and in the construction and arrangement of furnaces, flues, boilers, ovens, and retorts, having for their object the economical application of caloric, the manufacture of gas for illumination, and the consumption of smoke and other gaseous products."—28th.

Charles William Siemens, Manchester, engineer,—"Improvements in engines to be worked by steam and other fluids, and in economizing heat."—31st.

Thomas Marsden, Salford, Lancashire, machine-maker,—"Improvements in machinery for dressing or combing flax, wool, and other fibrous substances."—31st.

Henry Highton, Rugby, Warwickshire, clerk, master of arts, and Edward Highton, Regent's-park, Middlesex, civil engineer,—"Improvements in electric telegraphs."—31st.

Felix Alexander Testud de Beauregard, Paris, engineer,—"Improvements in generating steam, and in the means of obtaining power from steam-engines."—31st.

James Warren, Montague-terrace, Mile-end-road, Middlesex, gentleman, and Willoughby Theobald Monzani, St. James-terrace, Blue Anchor-road, Bermondsey, Surrey, gentleman,—"Improvements in the construction of bridges, aqueducts, and roofings."—August 2d.

William Bridges Adams, Adam-street, Adelphi, Middlesex, engineer, carriage builder, and contractor,—"Certain improvements in the construction of wheel carriages and locomotive engines, and also in roads or ways."—8th.

Jean Napoleon Zerman, Greenwich, Kent, captain in the French navy,—"Improvements in ships and other vessels."—8th.

Joseph Simpson, Manchester, civil engineer, and James Alfred Shipton, of the same place, engineer,—"Certain improvements in steam-engines."—14th.

Matthew Kirtley, Derby, engineer,—"Improvements in the manufacture of railway wheels."—15th.

John Weston, Portland Town, Middlesex, machinist,—"Certain improvements in obtaining and applying motive power."—15th.

Samuel Thornton, Birmingham, Warwickshire, merchant, and James Edward M'Connell, Wolverton, Buckinghamshire, engineer,—"Improvements in steam-engines, and in the means of retarding engines and carriages on railways, and in connecting railway carriages or waggons together; also improvements in effecting a communication between one part of a railway train and another by signals or otherwise."—18th.

James Porrit, Edenfield, Lancashire, woollen manufacturer,—"Certain improvements in carding engines, for carding wool and other fibrous substances."—18th.

Samuel Lees, of the firm of Hannah Lees and Sons, Park Bridge, Lancashire, iron manufacturer,—"Certain improvements in the manufacture of malleable iron."—18th.

Henry Henson Henson, Hampstead, Middlesex, gentleman,—"Certain improvements in railway carriages and waggons."—21st.

IRISH PATENTS.

Sealed from 20th July, 1848, to 20th August, 1848.

William Bridges Adams, Adam-street, Adelphi, Middlesex, engineer, carriage builder, and contractor,—"Certain improvements in the transport, storeage, and preservation of perishable articles, and in the construction of wheel carriages and locomotive engines, and also in roads or ways."—August 7th.

George Edmund Donisthrope, Leeds, Yorkshire, manufacturer,—"Improvements in roving and spinning wool and flax, and in treating wool previous to spinning, and in hackling flax."—10th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 21st July, 1848, to 16th August, 1848.

July 21th,	No. 1511.	Pretyman and Hobson, Cornhill,—"Child's cot."
—	1512.	Samuel Alfred Carpenter, Birmingham,—"Wedge apparatus (applied to the fronts of a brace, and applicable to other uses)."
22d,	1513.	Samuel Minshul, Birmingham,—"Hearse to be drawn by hand."
24th,	1514.	James Rowland, William Rich, and Robert Harris, 23 New Bond-street,—"The aptandum trousers."
25th,	1515.	W. and F. Thorn, John-street, Cavendish-square,—"The æquimotive spring."
—	1516.	R. W. Winfield, Birmingham,—"Gas burner."
—	1517.	Stock and Sharp, Birmingham,—"Gas burner."
26th,	1518.	James Hirst Whitehead, Ilkley, near Leeds,—"Stove-back."
28th,	1519.	John Phillips, Warwick-street, Belgrave-square,—"Siphon-trap."
29th,	1520.	John Joseph Hussey, Hertford-street, Fitzroy-square, carpenter,—"Portable meat screen."
Aug. 1st,	1521.	Samuel Ward, Lowther-arcade, Strand,—"Spring clip for candlesticks."
—	1522.	John Rock Day, Birmingham, and Job Clark, Willenhall,—"Bolt or fastening."
—	1523.	George Harborow, Holborn-bars,—"A pair of braces."
2d,	1524.	John Smith, Bradford,—"Corn-mill cylinder brush."
3d,	1525.	William P. Stanley, Peterborough, and John Medworth, Crown-street, Walworth-road,—"Farmers' steaming apparatus."
4th,	1526.	Thomas Burnham Clark, Lawrence Poutney-lane, London,—"A direction label."
5th,	1527.	John Brown, Sheffield,—"Conical spring for railway carriages, made of round, square, oval, hexagon, or octagon steel.
—	1528.	John Robert Grover, Castle-street, Holborn,—"Letter paper."
7th,	1529.	Thomas Porter, Strand,—"Shirts."
8th,	1530.	Thomas Dismore, Liverpool,—"Tassel fastener for brooches, clasps, buttons, &c."
—	1531.	Charles Twigg, Birmingham,—"A sewn-through shank papier mâché button."
—	1532.	Robinson and Russell, Mill Wall Works, Poplar,—"Wrought-iron railway wheel."
9th,	1534.	Cornelia Smith, Crew, Cheshire,—"Female elastic supporting band."
11th,	1535.	James Lamb Hancock, Coed-y-Cade, Montgomeryshire,—"Frame for a carpet or other bag."
14th,	1536.	Welch, Margetson, and Co., Cheapside,—"Back of a pair of braces."
—	1537.	John Whitehead, Preston,—"Tile machine."
15th,	1538.	John West, Lambeth, and John Henry Weston, Southwark,—"Moon, or globe, for gas or other lights."
16th,	1539.	John Warner and Sons, Cripplegate,—"Beer engine."

TO READERS AND CORRESPONDENTS.

J. Crane, Birmingham.—The crane possesses features of ingenuity, but we do not think it would answer well in practice. Compressed air or water would be far superior, as, instead of 15 lbs. only, he might get any pressure on the piston. According to his own calculation, he requires a 15-inch cylinder to lift 1 ton; and a 48-inch for 10 tons. The cost and unwieldy size of such cylinders would prove insuperable obstacles to the plan. It is also to be remarked, that he makes no provision for obtaining a long lift, as the piston must travel through the same space as the load.

C. T. S., Merthyr.—The Reports themselves are as full as possible. We have occasionally endeavoured to procure illustrations for them; a perusal of the leading article in our present part will explain the reason of our failure. His polite remarks lay us under some obligations, and we should be happy to attend to his last suggestion if it were possible.

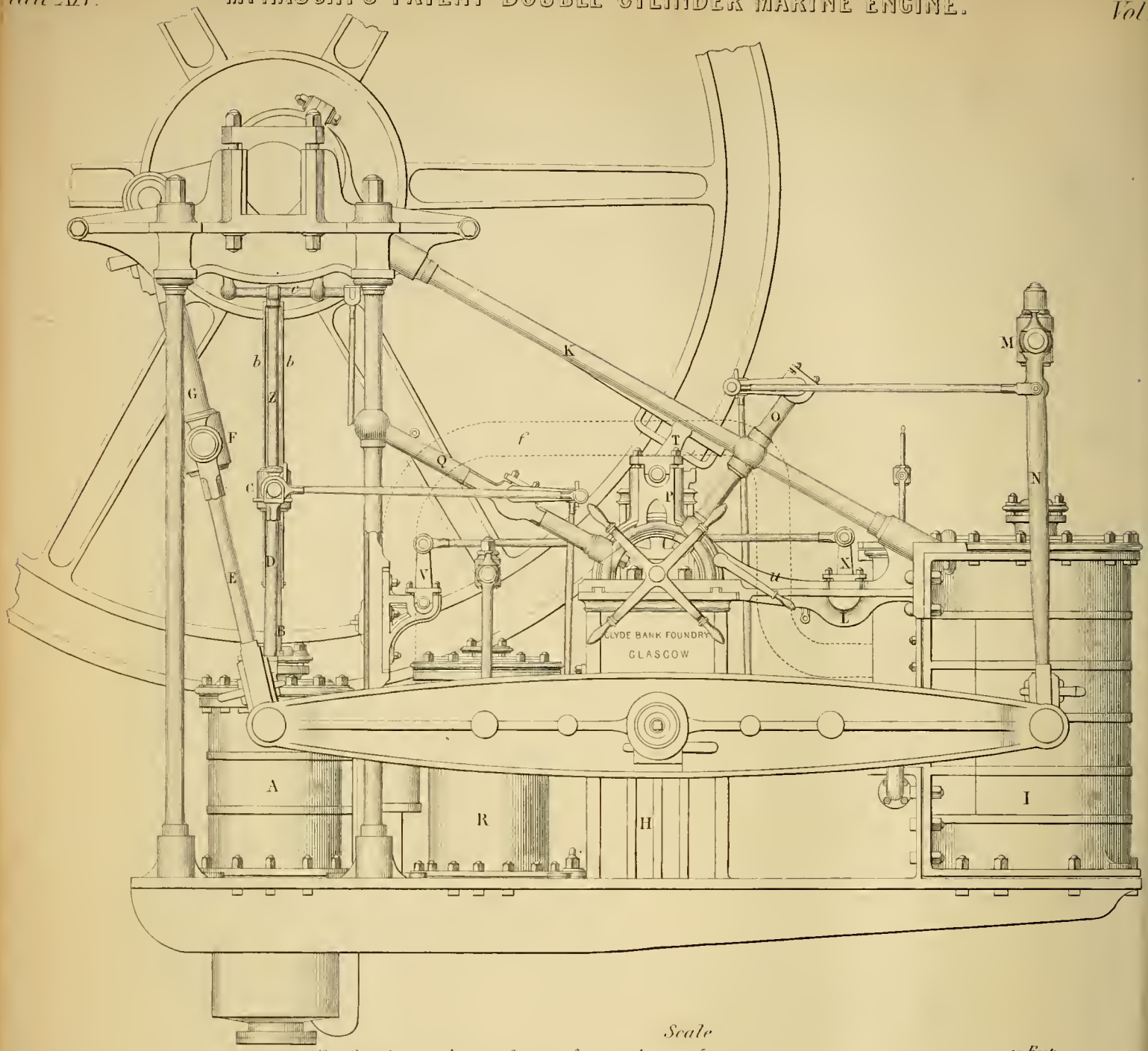
S. S., London.—Our Plates alone would prevent us issuing a stamped edition, were there no other objections. Each sheet must have its stamp.

J. R.—The scheme has been often published. It is clever, but we are not satisfied as to its practical utility. We shall have much pleasure in hearing from him again.

Registrar.—An application to the Patent Office, 33 Buchanan Street, Glasgow, will put him right.

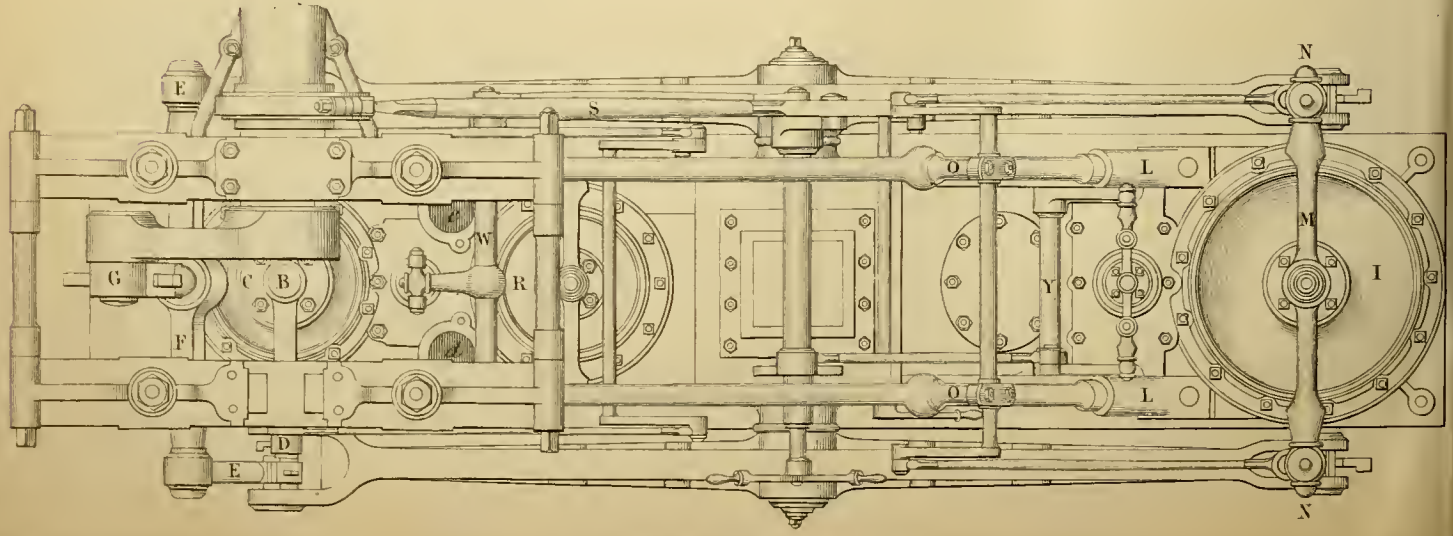
J. Thompson.—The Journal may be obtained through the Post Office, direct from the publisher, by transmitting 1s. 6d. in money or postage stamps.

☞ As a reply to several inquirers, we may state that novelties, or jottings from experience, are always acceptable, in whatever garb or in however small quantities they may arrive.



Scale

12 6 0 1 2 3 4 5 10 Feet



W. Johnson. Print Office Glas. gow.

G. Aikman

AT BLACKBURN.

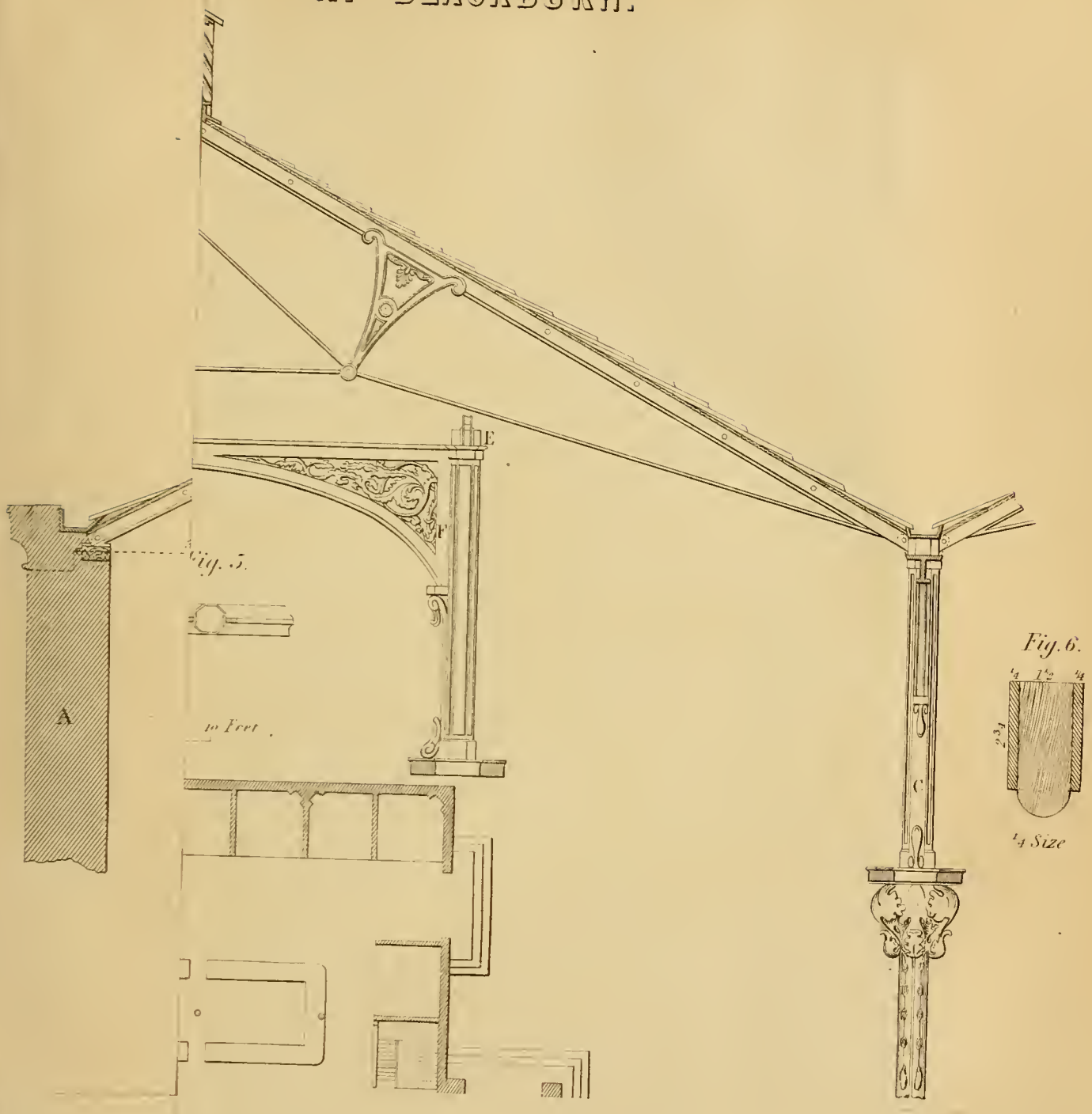
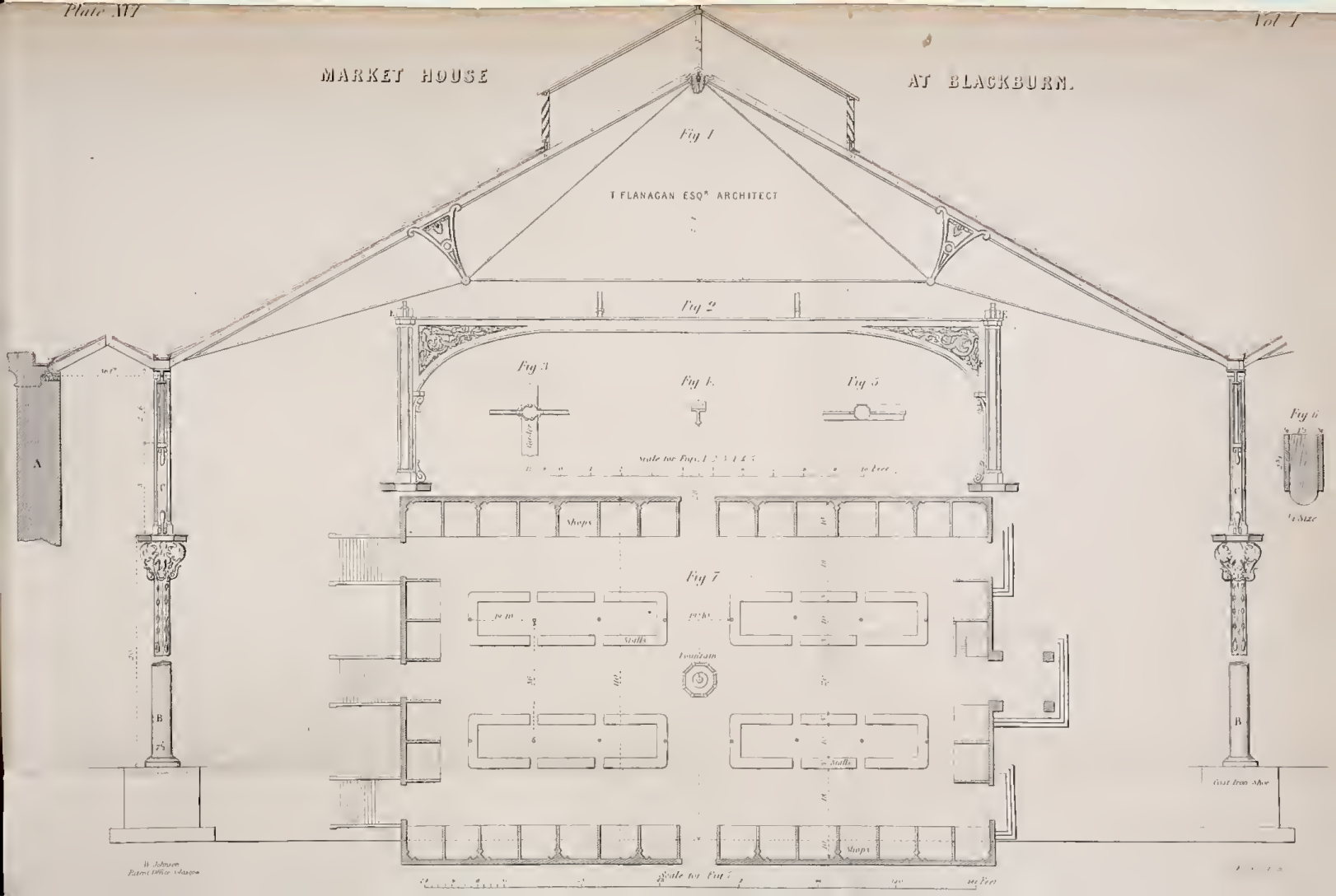


Fig. 6.

¼ Size

MARKET HOUSE AT BLACKBURN.



STEAM-ENGINE MANAGEMENT—BOILER EXPLOSIONS.

The concentration of productive energy, and the minute subdivision of pursuits ranking under the category of the conversion of materials, are two of the most remarkable features of the present manufacturing era. The introduction of an unlimited supply of power in the steam-engine has not only been the means of effecting an astonishing consolidation of mechanical operations, but has also reduced processes, originally complex and uncertain, to the status of mere calculations of labouring force. If we glance at the condition of machinery and manufactures as they were a century ago, we can hardly conceive that such crudities should ever have existed. Smeaton, in 1754, began the work of systematizing the practical details of his profession. To him we owe the introduction of cast-iron as a substitute for timber, his first application of it being as a shaft in one of his windmills. Some years later, he adopted it for the main shaft of a water-wheel employed in boring cannon at Carron; but it was not until the erection of the Albion Mills by Rennie, in 1784, that iron was used throughout an arrangement of gearing. The improvement effected in this particular, in conjunction with Watt's steam-engine, led the way for the magnificent results of later years, exemplified in the factory system. The irregular efforts of labourers turning winches, of horses walking their ceaseless round, and the uncertain impulses of the wind, have been superseded by the trusty steam-engine, whose assistance may always be relied upon, so long as he is not overtasked.

The manufacturer of 1748, who employed horses as his impelling power, required only a careful groom and driver for their proper management; but it does not therefore follow that his representative of 1848, who employs a complex machine like a steam-engine, should rely upon attendants of no higher grade. But what is the actual state of matters on this particular point, in numberless instances? Inexperienced boys, and illiterate and superannuated men, are often entrusted with the care of engines of vast power, requiring the closest attention of educated mechanics.

Our attention has lately been forcibly drawn to this subject, by the occurrence of several deplorably fatal steam-boiler explosions, which are to be directly referred to careless management. The case of the Hart's Hill explosion has been lucidly explained by Mr. Smith, and the profession owe him thanks for his assiduity in bringing forward the subject. The mismanagement of this boiler is sufficiently well shown by Mr. Smith, where he says—"I am sorry to say that the real cause of the accident seems still to be a mystery, it not being possible to ascertain the exact amount of weight upon the safety-valve at the time, from the great difference of statements made by the two enginemen, and the proprietor appearing to be perfectly ignorant of it himself." Again, in the investigation into the circumstances connected with the explosion at Mr. Riley's spindle factory at Manchester, it came out that a mere boy was the sole attendant. With examples like these before us, who can be surprised at the frequent occurrence of such results? We might address a volume of evidence of this unsafe system, but, meanwhile, we shall refer to two only of the latest, both of which occurred in Preston within a space of six weeks.

There is perhaps no other town in the kingdom, circumstanced like Preston, where, up to a late period, so few casualties of this nature have occurred, and the two cases which we are now about to cite have certainly taken us by surprise.

The first of these took place on the 17th of June, at the Royal Sovereign Mill in Stanley Street, owned and worked by Mr. Hollins of Stockport, an extensive cotton-spinner. The engine was a high pressure one of thirty horse power, supplied with steam by a cylindrical boiler, 26 feet long, and 7 feet 4 inches diameter, with flat ends and a single flue, very similar to boilers of the same class used in this neighbourhood. The boiler house formed the lower storey of the mill, having a joiner's shop and other rooms above. The explosion took place between half-past eight and nine, when the engine was stopped for breakfast, and a number of hands were in the boiler house, where they had breakfasted. Eight individuals, including the engine attendant, were killed by the explosion.

In this case, also, some misunderstanding appears to have existed with regard to the weights on the safety-valve. According to the evidence of Mr. Harrison the surgeon, Durham the engine-man stated, a short time before his death, that he had 50 lbs. upon the square inch, but being reminded by some party present at the time that he had only 36 lbs., he admitted, with some hesitation, that the latter statement was correct. The part of the boiler which gave way was the upper portion of the cylindrical tube forming the main flue. From an examination of this tube, it appeared to have been bare of water, and to have been heated to a very high degree, insomuch that the steam pressure finally broke down its upper surface. The proximate cause of the accident was undoubtedly the injudicious position of the fusible plug in the boiler; for, by the evidence of Mr. Beverage, with regard to the flue in which the fusible plug was placed, "from the second plate of the end of the boiler towards the chimney, until the fifth plate from the other end, it was $5\frac{5}{8}$th inches out of level. The plug is in the fourth plate, between $2\frac{1}{2}$ and 3 inches below the crown of the flue. The upper end of the boiler might be bare, if it is 5 inches out of level—one end might be dry, and the other covered with water." Now the fusible plug which ought to have been placed on the flue at the part likely to become bare first, was actually at the lower end, and consequently the greater portion of the flue might become heated long before the plug could be acted upon by the direct heat of the fire. We have also seen, from the evidence adduced above, that the plug was "between $2\frac{1}{2}$ and 3 inches below the crown of the flue," so that, for all practical purposes, it might as well have been on the top of the outer shell of the boiler.

The other explosion, which has added so much to the notoriety of Preston, occurred on the 31st of July last, at the Brunswick Mill, in the possession of Messrs. Cooper and Garrington, cotton-spinners. The boiler was of the old waggon construction, 24 feet 6 inches long by 8 feet wide, with an elliptical flue tube, 3 feet 3 inches by 2 feet 8 inches, and was made in 1843. As in the preceding case, the boiler house was beneath a counting house, mechanics' shop, and a winding and reeling room; the latter apartment being directly above the boilers. The accident occurred about 25 minutes past 11 in the forenoon, when the engineman and two bricklayers were in the boiler house, and eight females at work in the reeling room. Four of the females, and the three men before mentioned, were killed by the explosion, and the remaining four females in the reeling room were severely injured. The boiler was thrown forward from its seat a distance of $7\frac{1}{2}$ feet, breaking down the whole of its connections, and rupturing the ceiling above it. The concave sides of the boiler, forming the external flues, were bulged outwards to a distance of 15 inches; and the bottom, formed originally with a concavity of 1 foot 6 inches, was torn off and forced downwards a distance of 3 feet.

To explain the amount of the internal tensile strength of the boiler, it may be mentioned, that it was fitted with twelve transverse stays, of $1\frac{3}{4}$ inches square iron, with diagonal stays to the bottom, and two longitudinal ones.

Some time previous to the accident, the bottom of the boiler had been observed to be yielding to the downward pressure of the steam. Let us see what Mr. Clayton, the maker of the boiler, says in his evidence on this point. When asked if it was safe to use a boiler in such a condition, he stated, "that it is an indication of its giving way; an indication of what has happened indeed. It was not safe to use it at the pressure they were using it, that is, at the pressure which the engine required to drive the machinery. * * * I spoke to Mr. Fogg (the manager of

Messrs. Cooper and Garrington's works) about it, towards the middle of the second week in July, on Tuesday or Wednesday, I think it was. He called upon me at my office, and said that Mr. Garrington had sent him to inquire whether, if the boilers were circular instead of in their present shape, they would be stronger. I replied, that most decidedly the circular boilers would be the strongest. He then asked me what would be the cost of changing two of them from their present shape to that of circular boilers. I said it would be attended with great cost, and discountenanced the question by saying that it was not the boilers that were in fault, but that they wanted the engine to do more work than she was able to perform. The work required from the engine would need a greater pressure to drive the machinery than any waggon boiler would sustain. I told him that I considered they were running a very great risk by working them at the pressure that they appeared to do; and I asked him what had become of the boil-over pipes that had originally been placed upon them, in order to indicate their safety or danger? To that question he replied, that he had ordered them to be taken off. I asked him why he did that? He said, because the engine could not drive the machinery when they were up; they were perpetually boiling over. I said, yes, that was what I wanted, what I put them up for, so that they should boil over when the steam got to that height, sooner than do other mischief."

The boil-over or register pipe was originally 25 feet 8 inches high; but, as represented in the *Preston Guardian*, to which newspaper we are mainly indebted for the particulars we have gleaned, it had been taken down to the bottom length, which had a blank flange screwed on so as to entirely prevent the rising of a safety water column. In this way, the boiler, originally constructed to work at 9 lbs. per square inch, and which would have boiled over at something more than 12, was converted into an engine of destruction, by pressing it up to 20 or more pounds.

In the inquest in the case of the Royal Sovereign Mill, the jury simply returned a verdict of "accidental death," without attaching blame to any party. This was, doubtless, the only result at which they could arrive under the circumstances; for although, as we have seen, the safety arrangements of the boiler were far from satisfactory, yet the deficient water supply could be attributed to no other cause than inattention on the part of the engineman, who paid the penalty of his life for it.

The verdict, in the second case, in the face of all the direct evidence of culpability on the part of the manager and owners of the mill, was also "accidental death," but coupled with an "opinion that considerable blame is attached to the engineer and manager, in working the boiler a a higher pressure than it was calculated to bear." It is not to be wondered at, that the inhabitants of Preston should not be by any means satisfied with this superficial inquiry, and the attention of Government has since been drawn to the matter, with a view to a further investigation. This has resulted in the preferring of an indictment for manslaughter, against Fogg the manager of the mill; thus directly reflecting upon the impotency of the coroner's inquest, and the emptiness of the verdict of an unthinking and unscientific jury.

It is a lamentable fact, that whilst the state of engineering science is such that power and work may be most accurately proportioned to each other, that a certain amount of labouring force may be measured out with the greatest exactitude, and that the employer of mechanical power may calculate almost to a hair's breadth the dynamical effects of a ton of his coals, such defective arrangements, as those at the Brunswick Mill, should exist. We find ourselves compelled to admit, that whilst this country presents such an array of engineering skill for the erection and practical working of steam-engines and their dependent machinery, yet men, whose qualifications rank no higher than those of mere labourers, are nominated to these posts. We have no hesitation in saying, that the great bulk of the steam power in the manufacturing districts is under the guidance of a class of men whose education has by no means fitted them for the task. It is quite true, that in most large and well-arranged factories, where a great amount of steam power is in use, a superintending engineer or mechanic, of superior attainments, is appointed, who selects his own operative engineers and fire-men, and tutors them to his own system. But this is far from a general case, and the mill-owner commonly relies solely upon the superintendent of his productive machinery, who is, perhaps, not practically acquainted with steam-engines, and leaves this department to mere fire-men.

The state of Mr. Fogg's engineering information requires little further comment, after the evidence of Mr. Clayton, who gives us to understand that he knew not whether a waggon or a cylindrical boiler was strongest, or that he was committing a most insane action by removing the boil-over pipes, and turning a bulky, ill-shaped, low-pressure waggon boiler into a high-pressure one. From the evidence so far obtained, it does not appear who authorized the adoption of so high a working pressure—whether the manager did it on his own responsibility, or was ordered by the owners to do it, we know not; in either case, his ignorance or recklessness is self-evident. An abortive attempt was made, through a book-keeper of the establishment, who could know nothing of engineering matters, to show that the engineman had received injunctions not to carry a higher pressure than 10 lbs. If this had been the case, why were the boil-over pipes removed?

Every engineer knows the schemes which are resorted to for obtaining an increase of power without erecting a new engine; in this case, the worst expedient—namely, a higher pressure—was made use of. Now, the waggon-shaped boiler is perhaps the worst kind that can be conceived for standing a high degree of pressure. It was introduced by Watt as a means of obtaining a great available heating surface, when steam of 4 or 5 lbs. only was in use. Modern practice shows that the waggon shape does actually present no superiority in this particular over the plain cylinder, and the latter is immeasurably safer, for every portion of the cylindrical surface bears its due amount of pressure. Not so in the waggon boiler, where the bottom and side inward curves are most injudicious, and are only safe when assisted by a strong series of stays. There is another important point to be remarked upon; that is, the placing of boilers beneath work rooms. The boiler house should always be an independent building, and not, as in most of the older class of factories, below a tall pile of thickly peopled storeys.

The frequent occurrence of accidents of the kind under notice, seems to point to Government inspection as a remedy; and although we are decidedly averse to legislative interference in private speculations, we are at a loss to see how the safety of the operative classes can well be secured against the short-sighted economy too often pursued by employers. In order to save a few shillings in the wages of an engineman, a mere shoveller of coals is employed, in place of a man who has made the steam-engine his study. We do not mean to put forward any nostrums or certain specifics for the prevention of accidents, for every well-informed engineer knows that nothing can compensate for inattention to details. We may, however, next month offer a few suggestions on the economical arrangement of boilers intended for a high pressure, in connection with the boiler and fittings for the engine contained in Plate 14.

ANATOMY OF THE PHYSICAL STRUCTURE OF THE UNIVERSE.

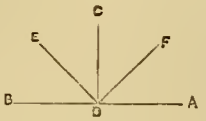
By Mr. R. Smith, Blackforn.

IV.—Light.

The atmosphere being a vehicle of light as well as of sound, the light emitted by the heavenly bodies is, by its refractive power, diffused over the surface of the earth, bestowing a radiant beauty on mountain and plain. This light is also very considerably increased by the reflected light emerging from the variously coloured objects that surround us. Had these objects been black, none of the reflected rays of the sun would be returned back into the general mass, black being the negative of all colours.

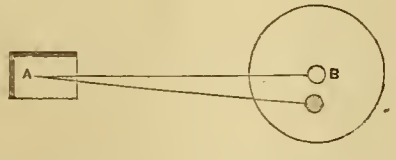
A single drop of dew lying silently upon the lap of a leaf, exhibits two important laws in optical science—refraction and reflection—the centre of the globule producing white light, whilst its circumference is tinged with prismatic rays; and if the fibres of the supporting leaf are viewed through the drop, they will appear greatly magnified. Again, the smooth surface of a lake bears upon it the outline and tints of the objects surrounding it. Thus, the natural magnifying power of the dew-drop may be said to have suggested the idea of the microscope, and the glassy lake that of the mirror. Similarly, a temporary prism of ice probably offered the hint for the construction of a permanent one of glass; and the internal mechanism of the eye points to its artificial reproduction—the camera obscura.

Rays of light are reflected from every visible object, and millions of observers may behold the same thing at the same time, for the rays proceed from every part of it, and traverse in all directions, so as to fall upon the eye at innumerable angles. Let A B represent a plane mirror, placed with its reflecting surface accurately horizontal, and let C D represent a ray of light falling upon it perpendicularly, then the line of reflection of this ray will be precisely in the same path, C D; or, in other terms, the ray of incidence and the ray of reflection will be in the same line of direction.



But if the ray meets the reflecting surface at any other than a right angle, as at 45°, E D, the ray of reflection, D F, will emanate from the reflecting surface at an angle identical with the angle of incidence, but on the opposite side of the imaginary centre or perpendicular line, C D. This law holds good for all forms of reflecting surfaces—plain, convex, or concave—and when it is kept in view, the angle of reflection is at once known, when that of incidence is given.

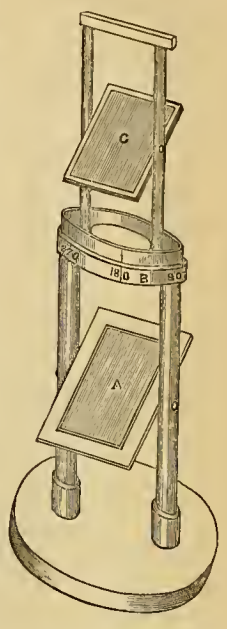
If two plates of glass are placed in contact, a ray of light let fall upon the surface of one of them becomes doubled, an image being formed by each piece. The author has devised a method by which these reflections may be seen most advantageously. Two plates are placed with their planes in parallel lines, and at a slight distance asunder, and are joined by cement at their edges, the inclosed space being filled with coloured liquid, such as the ammoniacal sulphate of copper, and the whole is placed as at A. When a sunbeam falls upon the surface of the apparatus, two images are reflected upon the white disc, B, a white and a blue one. If the plates are now turned round in the same plane, the blue image will revolve round the white one.



If the two plates are placed in a horizontal position upon a table, and a ray of light is permitted to descend obliquely upon the surface, the eye being placed at the same angle on the opposite side of the ray, the revolution of the apparatus will cause a similar motion of the blue image. In this experiment, the colourless image is reflected from the surface of the glass, and the blue one, being refracted through the glass, is reflected from the coloured medium in the centre of the two sheets. It is yet difficult to account for the phenomenon of rotation; probably it is owing to the arrangement of the primitive form of the medium through which the light passes, refracting the ray always in the same direction, so that the image becomes determined in the same position, and when the medium is moved round, the image moves along with it, whilst the reflected one remains stationary on the centre of the glass.

The phenomenon of the polarization of light was discovered in 1810, by M. Malus, a French philosopher of eminence. This discovery laid open a new field of inquiry, rivalling in splendour the widely extended arena of physico-mathematical science. Polarized light may be produced in three different ways—by reflection from the surface either of transparent or opaque bodies—by refraction or transmission through planes or plates of uncrystalized bodies—and by transmission through crystalized bodies possessing the property of double refraction. In the polarization of light, a ray of common light is separated into two rays, having different properties, one of which is the production of colour in various ways, although the primitive ray is white.

Various mechanical arrangements have been invented for the illustration of this remarkable property of light; the polariscope of M. Biot, introduced in 1824, is perhaps the best of its kind. The annexed figure will explain this apparatus. A, is a frame containing a number of plates of glass placed parallel with each other, and termed the polarizing glass; it is swung on two side pillars, in the fashion of a mirror. The tops of the two side pillars carry a circular ring of wood, B, into which is loosely fitted a moveable upper circular disc of wood, with a central opening. This upper disc again carries two light pillars, supporting a second frame, C, containing a sheet of glass, painted on the back with lamp black, termed the analyzing glass. The upper wooden ring has an index placed opposite to the middle of the analyzing glass, so as to point to graduations on the outer or lower ring, B. The substances to be submitted to the action of polarized light are placed over the hole in the upper ring, by a small disc of glass, forming a supporting stage.



To show the difference between polarized and common light, the polarizing and analyzing glasses are set with their faces parallel to each other, as represented in our figure, and a ray of light, whose angle of incidence is 56°, is allowed to fall upon the polarizing plate, so that it may be reflected to the analyzing one above. Supposing, now, that the analyzing plate is turned slowly round, the reflected light upon it will become gradually fainter, until it has been turned 90°, when the light will be barely visible. If the motion is still continued onwards, the light will again become brighter until it reaches the opposite 90°, at which point its intensity will be the same as at first. At 0°, and at 180°, the intensity is greatest; and at 90° and 270°, it is least. If we suppose the polariscope to be placed with 0, pointing to the south, it follows that when the north or south side of the ray, reflected from the polarizing plate, is towards the analyzing plate, the plate reflects it as a common light; but when the east or west side is nearest the analyzing plate, it is incapable of reflecting the light, and at the intermediate points different degrees are reflected, showing the difference existing between polarized and common light. So far as we at present know, light, in polarization, undergoes no other change than such as is caused by reflection; therefore we come to the conclusion that light is polarized by reflection from glass at an angle of 56°, water 52° 45′, and so on, according to the substance used. The fact of the refusal of polarized light to be reflected from the surface of a transparent substance, when it is incident at an angle of 56°, and that it is the same in two positions at right angles to each other, is a clear test of polarization.

Opaque bodies, as well as transparent ones, possess the property of polarization by reflection, as ebony, black marble, and other substances. The author finds that a piece of jet, or parrot coal, with a polished surface, forms an excellent polarizing plate, superior, perhaps, to all others, when no great amount of illumination is required.

Sir D. Brewster has introduced a beautiful variation of the polariscope test. The instrument is placed as previously described, and the analyzing plate is turned round until the image disappears. If the plate is breathed on, the image will immediately return, owing to the thin film of water on the glass, bringing its different polarizing angle to bear upon the light. Again, if the analyzing plate is set at an angle of 52° 45′ to that of the reflected ray, part of the polarized ray will be visible; but if we breathe upon the glass, the image will disappear, for the reason of the substitution of a film of water for the glass. Sir D. Brewster measured the polarizing angles of a great number of transparent bodies, and by comparing them, he arrived at the law, "that the index of refraction for any transparent body is the tangent of its angle of polarization." This law was confirmed by the following observations:—

	Observed Polarizing Angle.	Calculated Polarizing Angle.
Air	40° or 47°	45° or 32°
Water	53 14	53 11
Fluor Spar	54 50	55 9
Obsidian	56 3	56 6
Sulphate of Lime	56 28	56 45
Crown Glass	56 12	56 45
Rock Crystal	57 22	56 58
Sulphate of Barytes	57 47 58 0 58 29	58 33
Topaz	58 40 59 0	58 34 58 50

	Observed Polarizing Angle.			Calculated Polarizing Angle.	
Mother of Pearl ...	... 58	47	....	58	51
Iceland Spar ...	... 58	51	.....	60	25
Spinelle Ruby ...	... 60	16	..... .	63	0
Zircon	. . 63	8	.....	64	30
Glass of Antimony	... 64	45	....	63	45
Sulphur	... 64	10	..... .	0	0
Diamond	... 68 / 67 / 67	2 / 13 / 0	.....	68	1
Chromate of Lead	... 67	48	.....	68	3

OUTLINE OF ASTRONOMY.

No. I.

If on some fine night we place ourselves in the open air, and direct our observations to the heavens above, we may perceive that a change occurs in their position every instant. Continuing our survey, we shall notice that stars are rising and sinking: some climb out of the east into the sky, others disappear in the west; several, such as the constellations of the Great Bear and Cassiopeia, never (in our latitude) reach the horizon at all. But whilst the movement is universal, the position of the stars with reference to one another continues the same; they all describe circles which are less, the nearer they are to the polar star, which alone remains motionless. Thus the heavens appear to turn upon two fixed points, named for this reason, poles; and in this motion the entire system of stars is involved. The pole which is elevated above our horizon, is the northern, or arctic pole; the opposite one, is the southern or antarctic pole.

With these facts before us, many highly interesting questions present themselves to us for solution. What during the day becomes of the stars which we see at night? Whence come those which we see rise, and whither depart those which set? An attentive examination of the phenomena will furnish us with replies to these questions. At the dawn of day we may perceive the stars growing dim before the increasing light, whilst, in an evening, they are seen to acquire lustre as the daylight disappears. These are proofs that it is not because they cease to be, but that their brightness is lost and extinguished by the overwhelming light of the sun, that we do not behold the stars by day, and the telescope enables us to verify this explanation in rendering them visible to us even at noon. Those which are near the pole describe circles whose entire circumference is visible; it is natural to suppose that those stars which rise and set, continue to describe beneath the horizon the circles which they commenced above it; and in truth, as we advance northward, the circles of such stars as are situate in that part are rendered more and more complete, until the whole circle is described within our view. The contrary is observed if we move in the other direction. Stars which were constantly above the horizon, are now seen to rise and set, and stars, unseen before, begin to appear. It is evident, then, that the earth is not what it appears to be, a plain supporting the celestial vault. Such an erroneous opinion was entertained by men in early times, but a consideration of phenomena, such as we have noticed, afterwards led them to a different conclusion. They acknowledged that the heavens surrounded the earth, and that the stars shine unceasingly in describing every day their several courses.

In order to form a precise idea of the motions of the stars, we may conceive an axis passed through the centre of the earth, and the two poles of the world, round which the celestial sphere revolves. The great circle perpendicular to this axis is called the *equator;* the small circles which the stars seem to describe parallel to the equator by reason of their diurnal motion, are termed *parallels;* the *zenith* of the observer is that point of the sky which is immediately above his head, and the *nadir* is the point beneath his feet. The *meridian* is the great circle which passes through the zenith, the nadir, and the poles; it cuts into equal parts the arc described by the stars above the horizon, and when they reach it they are at their greatest apparent height. Lastly, the *horizon* is the great circle drawn round the observer parallel to the surface of still water.

In journeying towards the pole, we see the polar star mount higher and higher so that it is clear the surface of the earth is convex, and in fact its shape is not very far from a sphere. The curvature of the terrestrial globe is perceptible on the sea, although it is only one foot in 5250. But it increases as the square of the distance; for instance, in 5250 feet × 4, it amounts to 16 feet, and in applying this calculation to a quarter of the earth's circumference, we find that it gives us the length of the terrestrial radius. The first thing which we ought to ascertain in astronomy, is the pole of the world. This is very easy. The constellation called the Great Bear is well known. Now, if we draw a line through the two stars which are the farthest from the tail, and carry it forward, it will pass through or very near the polar star. Equidistant from the two poles is the equator, along which the sun moves at the epochs of the equinoxes, and which divides the globe into two hemispheres, northern and southern. The meridian line which divides the day into two equal parts, changes with every step we take to the east or west of our present position, since, as we have said, it passes through the zenith of the poles. The only method of changing our place without changing the meridian, is to move directly north or south, that is, towards one of the poles. To us, in these latitudes, the north pole is elevated above us towards the north, the equator in the south, and the amount of these elevations is the first object of observation. In seeing the stars turn daily round the pole, it was easy to calculate how high they rise, and to what depth they sink; and thus we find, that at London, the pole is elevated about 51½ degrees; at Glasgow, 56 degrees; that is to say, these places are respectively 51½ and 49 degrees from the equator, which itself is elevated 38½ and 34—for the elevation of the equator is the number of degrees wanting to make up 90. These distances are what we term *latitudes.*

The first notion with which the mind is impressed as we view the heavens at night, is that the earth is the centre of all its movements. For a long time this was the general opinion, and Ptolemy adopted it, although Pythagoras, Aristarchus of Samos, and Nicetas, had affirmed that the sun is the motionless centre, round which the planets harmoniously circulate. But it was reserved for Copernicus, and his disciple Galileo, to demonstrate, by invincible arguments, the stability of the sun, and the double rotation of the earth and the other planets. Kepler, by the discovery of the laws that bear his name, and Newton, by discovering those of attraction, made this system a mathematical certainty. To the untutored mind, the alleged motion of the earth may be difficult to conceive, being apparently so completely contradicted by the evidence of the senses. But it is more easy to believe this, than to believe that all the multitude of stars, more than 75 millions in number, and the planets and the comets, revolve round this little speck of ours. Besides, when the telescope informs us that all the planets turn every day upon their axes, it cannot be difficult to admit that the earth turns upon hers, and moreover, circulates round the sun, for a body does not revolve round its own axis, without advancing at the same time in space. There is also another indication of the earth's annual revolution. As soon as the planets are in opposition to the sun, they appear to retrograde; that is to say, that instead of moving from west to east, in accordance with the usual scheme of celestial motions, they stop and return upon their steps by a movement towards the west. Copernicus soon saw that this was the result of the earth's motion, since, in passing between the sun and these planets, and in moving more quickly than they towards the east, it leaves them behind, that is, towards the west, so that they seem to move in a direction contrary to that in which we move, and to that in which they themselves really move.

We may plainly see Mercury and Venus turning round the sun, because they are always near him, and they appear to approach and recede alternately; and they are apparently larger when they are on this side, and less when on the other side of the sun. The discovery of the telescope in 1610, rendered the phenomenon more evident by the phases of Venus, which shows a full and complete disc, when it is directly on the other side of the sun; it is crescent when it is nearer us than the sun, and on one side; and when it passes in front of the sun it appears like a black spot. All this proves that Venus is sometimes beyond, sometimes on this side of the sun—in other words, that she revolves round it. And so with Mercury, which has been seen to pass over the sun's disc twenty several times, a remarkable instance occurring in 1832. Thus the movement of the planet around the sun very much simplifies the explanation of their apparent irregularities, and leads us to admit a similar movement in the earth.

The objection to the earth's motion that has been oftenest repeated is this: If it turns round its own axis in twenty-four hours, all the parts of the surface must move with a great swiftness to the east, and a stone thrown into the air directly upwards, would fall to the west of the place from which it was thrown, and at a distance from that place equal to the extent by which the earth has been removed during the interval between the stone being projected and its again reaching the ground. But this reasoning is erroneous, for a body when once impressed with motion will preserve it until it has been changed by some external force, and the stone being impressed with the earth's motion on its leaving the surface, that impression continues until it reaches it again. Consequently, the stone when in the air moved to the east just as rapidly as the earth, and therefore it would fall precisely at the spot from which it was thrown

up. Again, if we drop a stone from the topmast of a ship in motion, we shall find it fall exactly at the foot, as if the vessel were at rest, because the motion of the ship is communicated to the stone the moment it leaves the hand.

Since the planets turn round the sun, it would seem necessary that we place ourselves at the centre point in order to comprehend the circumstances, the rules, or the laws of their motions. But there are occasions when the earth is so placed, that we can observe just as well as if we were placed at the centre, and by taking advantage of them we have acquired a knowledge of the laws governing the motions of the planets. Kepler, guided by his mighty genius, and profiting by the observations of Tycho Brahe, but without the help of any instrument, discovered those sublime laws by which he has justly earned the name of the legislator of astronomy. He showed—

1. That the course of the planets round the sun is elliptical, not circular, and that the sun occupies one of the foci.

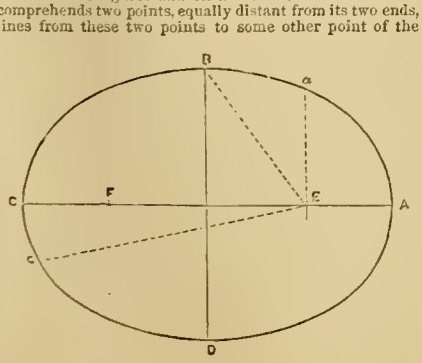
2. That the radii vectores describe areas proportionally to the times, that is to say, that the progress of the planets has not, in every part of their course, the same rapidity, for the further the planet is from the sun, the slower is its motion; the nearer it approaches, the quicker it moves: it is exactly in proportion to the areas described by the radius vector, or to the surface of a triangle of which two sides are formed by the distance of the planet from the sun at any two times, and the third side by the arc which the same planet describes in its progress from the two points. We see, then, that the arc (or the space moved over) must diminish proportionally to the lengthening of the radius vector, or of the distance of the planet from the sun.*

3. The squares of the periodical times of the planets are to one another, as the cubes of their mean distances from the sun. Thus, Jupiter is about $5\frac{1}{4}$ times farther from the sun than the earth, and if we cube this number, we shall have (nearly) the number 144. Now, it takes Jupiter twelve of the earth's years to perform a single revolution round the sun, and the square of 12 is 144. When the calculation is rigorously made, the two results correspond exactly. We may state the law thus: the cube roots of the squares of the times of the planets, are to one another as the distance of the first planet from the sun is to the distance of the second. It is sufficient to know the distance of any one planet, and the time of its several revolutions, in order to find immediately the distance of any other planet, provided that we know the exact time of its several revolutions. Thus, the distance of the earth from the sun, and the time of its revolution being ascertained, knowing that Jupiter takes 12 years to perform his circuit, we square this number ($12 \times 12 = 144$), and then extract the cube root (the result being about $5\frac{1}{4}$), we obtain the number of times of which Jupiter is more distant from the sun than the earth. Saturn takes 30 years to accomplish his revolution; the square of 30 is 900, and the cube root of this number is about $9\frac{1}{2}$. This represents the distance of that planet from the sun, taking the earth's distance as 1. If we desire to have the absolute distance of Saturn from the sun, as well as his comparative distance, we multiply 95 millions of miles (the earth's distance from the sun) by $9\frac{1}{2}$. As to the distance of a planet whose revolution round the sun is less than the earth's—Venus, for example—we say—the square of 365 days (time of the earth's revolution) is to the square of 224 days (time of the revolution of Venus) as the cube of 95 millions of miles (the earth's distance from the sun) is to a fourth term, of which the square root will be the distance of the planets from the sun. The same calculation may be applied to the satellites.

From these instances, we perceive the utility of Kepler's laws. They were the happy result of the art of observing facts and their connecting links. All the planetary movements are found to be united by a common principle, and since that principle comprehends the earth, we have a new proof of the earth's motion. When we reflect on the accuracy and the simplicity of these laws—when we consider that they evidently guided Newton in his grand discovery—one cannot fail to recognize in the following lines, written by Kepler, the enthusiasm of a powerful imagination dazzled by the sudden discovery of the sublimest truths:—"At length," he said, "after eighteen months, a new light has beamed upon me, and in the ineffable day I have a glimpse of the pure rays of the eternal Verity. The die is cast. I write this book; whether it will be read by my contemporaries or by posterity is of no consequence: it may well wait for a century before having a reader, since God himself has waited 6000 years before finding an observer like me."

The movement of the earth round the sun, and the immobility of that star as regards ourselves, does not, however, prevent our system, as a whole, being subject to certain disturbances. In fact, we shall afterwards see that all the celestial bodies gravitate towards one another, and that the sun, turning on his own axis, must necessarily advance in space, drawing after him the earth, the planets, and the comets.

* We give in a note an explanation of the figures and terms referred to above. An *ellipse* is a curved figure which comprehends two points, equally distant from its two ends, and such, that if we draw two lines from these two points to some other point of the ellipse, their sum is equal to the great axis of the figure. Thus, the figure A B C D, is an ellipse of which the line, A C, represents the major axis, and the line, B D, the minor axis, and the points, E F, are the foci. If we suppose the sun at E, then the curve is the shape of the earth's orbit. Lines drawn from a focus to the curve are termed radii vectores; thus each of the lines, E *a*, E B, E C, and E *c*, is a radius vector. The meaning of the second law stated above is this: when the space enclosed by any angle, such as *a* E B, is equal to that enclosed by another angle, such as C E *c*, then the times of the planet moving along the curves subtended by the two angles will also be equal.



IMPROVEMENTS IN RAILWAY SIGNALS.

A perfect system of signals constitutes a most important department of the apparatus of railways, as very much depends upon the regularity and simplicity of signals for the safe conduct of traffic. Railway signals, to be efficiently worked, should be distinctly seen at a distance, generally of at least half a mile from the station at which they are erected. The necessity for this is plain, when the high speeds at which trains are moved are taken into account. It is especially necessary at curved parts of railways, where every appearance of danger may be hidden from the engine-driver. The desideratum has led to the adoption of expensive and inconvenient signal apparatus, towering into the air some thirty or forty feet, so as to be visible over intervening obstacles. The insufficiency of the ordinary signals, about 12 feet high, was much felt on the North British Railway, at the St. Margaret's station, which is approached in both directions on curved parts of the line, and is entirely concealed by intervening buildings from the view of an engine-driver until he is close on the station. On this account, the locomotive superintendent, Mr. Thornton, found it necessary to remove the signals to about 100 feet above and below the station, and connect them to the handles by $\frac{3}{4}$ inch round iron rods, joined together and guided in wrought iron slides, screwed to a timber sole, with the necessary lever appendages. By this means, though the signal was removed to a distance, the signal man remained at his first post. The rod connection was next applied to the signals erected at the junction of the Hawick branch, with the North British main line; there they were removed to a distance of about 200 feet from the junction, under the charge of the pointsman, who had to work the points and the signals in concert. In this case, the great length of rod required to work the signals was found to be a serious obstacle, as, in dusty weather, the slides got choked up, and it was sometimes beyond the power of one man to work the apparatus; and, in rough weather, the difficulty was increased, as the signals presented a very large surface to the wind. The necessity of the case led to the idea of substituting a *wire* for the iron rod, and to work the signal by a *pull* instead of a thrust, the wire being kept in tension by a weight on the off side of the signal. A piece of telegraph wire was substituted for the rod, and was carried at proper intervals over pulleys, and attached to the lever of the signal. The working of the signals was thereby rendered quite practicable; and in consequence the wire connection was applied to all the signals along the railway. It was found that the telegraph wire was liable to snap, and some inconvenience on that score having been experienced, a small wire rope, about a quarter of an inch in diameter, is now used for the connection. Since the practicability of this species of connection has been tested, it has been extensively employed on other railways in Scotland. Messrs. Tod and Son, of Edinburgh, have fitted up several of the improved signals; they have also been the first to erect what may be termed the sympathetic signal, employed in connection with junctions and sidings, the signal and the points being so connected that one handle works both simultaneously. Some years ago, Mr. Thornton contrived and erected a sympathetic signal on the Edinburgh and Glasgow Railway, in connection with a stop rail placed on a siding, and working similarly to Tod's signals.

Of late, we believe, it has been suggested by R. Skeldon, a pointsman on the North British Railway, to adapt a balance-weight at the handle end of the wire rope, the weight being fastened to the end of the wire passed over a pulley fastened on the axis of the handle. The object of the balance-weight is to counteract the weight at the signal end of the rope, and prevent the violent action of this weight in lifting the handle

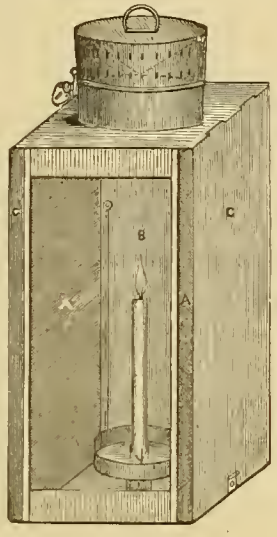
when released, accidents having once or twice occurred from the unexpected starting of the handle.

We may recur to this subject next month, and introduce some of the details connected with it. In the meantime, we should be glad to hear from any of our English readers about the progress of improvement in railway signals in England.

CRANE'S SAFETY MINING LANTERN.

During last month, we have been favoured by Mr. Crane of Cannon Street, Birmingham, with two complete safety mining lanterns, of his invention, one of which we have engraved, to accompany this description. Actuated by no other motive than a laudable desire to lessen the numberless dangers to which the miner is exposed, Mr. Crane has endeavoured to produce a lantern, which, whilst it will afford a clear light, will, at the same time, be more secure than the so-called safety lamps at present in use.

Our engraving is on a scale of one-sixth the actual size of the larger class of lanterns, with glass fronts. It is composed entirely of japanned tin, with wire-gauze on the two sides, A A, and a back, B, of polished tin, to act as a reflector. The wire-gauze contains 900 apertures in the square inch; it is securely soldered all round to the edges of the tin. Covers, C C, are hinged to the top on each side, so as to protect the sheets of gauze, the bottom of each cover being turned inwards about $\frac{3}{8}$ inch, thus retaining it at that distance from the gauze surface, in order to provide space for the passage of air, for the supply of the light. These covers are intended to protect the wire gauze from injury and dirt, and to prevent any current or "blower" of gas from putting out the light. No direct current can possibly act upon the light in the interior, for the reason that it can only find entrance in an oblique direction at each corner. The two lamps before us are intended for burning composition, or "patent wick candles," which require no snuffing. The candle is held between the four metal points, which are soldered in the dish of a moveable socket, the bottom of which fits into a fixed socket on the bottom of the lantern: this dish is useful for retaining the waste tallow which may run down the sides of the candle, and, in this respect, will answer for what housewives term a "save-all." The candle is put in through the door at the top, by means of the long wire handle projecting upwards. This door, or lid, fits on the top of a cylindrical neck, to which it is hinged; it is provided with a padlock, so that imprudent parties may be prevented from opening the lantern in dangerous workings. The smoke and heated air escape from the interior by a series of holes formed round the lid, to the top of which is fixed a stout ring for the support of the lantern. This ring is kept cool by a most ingeniously simple contrivance—a piece of tin bent into the form of an inverted cone, is soldered to the inside of the lid, and acts as a guide for the heated air towards the sides, where it escapes through the openings. All chance of inflammable gas entering by the lid is removed, by placing a sheet of wire gauze over the rim of the lid. Thus, no air can enter but by the wire gauze, and as this cannot get red hot, no explosion can occur at that part.



1-6th.

The smaller lantern is only eight inches high, but of the same width as the one we have engraved. It has no glass front, all the three sides being filled up with wire gauze. Although the inventor states that he prefers candles to oil, for these lanterns, yet oil may be used in them with the same facility. As it is impossible to prevent the miners from exposing their lights in a very imprudent manner, the lock-up system is provided as a remedy, and at the same time the reason for opening it, namely, the obscure light, is removed, by substituting a glass front for the wire gauze.

We are not informed of the particular reasons for the preference of candles over oil, and to us the use of the former appears to involve a practical objection in a material point. We refer to the testing of the air in pits, by means of these lanterns. In the Davy lamps, the smallest possible flame may be most accurately regulated, but the flame of the candle cannot be altered. It is also to be supposed that the great heat generated in the interior of these lamps when carried into an explosive medium, would melt the candles. The glass front will be an immense advantage in point of light, for nearly every accident from explosion owes its origin to the very meagre light afforded through the wire gauze, compelling the owner to open the lamp door. If an efficent plan could be adopted for the protection of these lanterns from injury, we are persuaded they will be found very serviceable; as it is, if the glass is fractured, the miner is at the mercy of the explosive medium which surrounds him. Probably, a few bars put across the front might act as a protection against danger on this score.

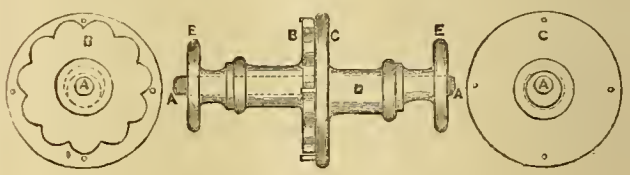
The immense loss of life continually occurring from fire-damp explosions, sufficiently urges upon us the necessity of investigating into every means for the protection of the miner, fifty lives having been lost within a month back. Mr. Crane's invention being unprotected, is open to trial by any parties connected with mining, and we shall have much pleasure in showing and explaining the construction of these lanterns to any one who may call at our office for the purpose.

MECHANICAL ECCENTRICITIES.—ROBERTS' NEW ELEMENT OF MECHANISM.—THOMSON'S MULTIPLYING GEARING.

A curious mechanical contrivance was brought before the British Association at the last meeting, by Richard Roberts, Esq., of the Globe Works, Manchester. The idea, which was suggested by the dial movement of an American clock, presents a ground-work for the obtainment of a great variety of movements in a most simple manner.

Fig. 1 is a half-size elevation of the model exhibited, and figs. 2 and 3 are end elevations of the two operating discs, with the actuating milled

Fig. 2. Fig. 1. Fig. 3.



½

heads removed. A, Is a steel shaft carrying two brass discs, B and C, fitted loosely upon it, and provided with long steadying bosses. The disc, B, has eleven teeth cut in its circumference, which teeth are well rounded at top and bottom, as represented in fig. 2. The other disc, C, which is slightly larger, is fitted on an eccentric portion of the shaft at D, where the eccentricity is shown by the increased diameter of the dotted shaft. It carries on its face four stud pins, set at equal distances from each other, and at such a distance from the centre of motion as to admit of their being brought successively to the bottoms of the hollows of the teeth in the disc, B, by the revolutions of the eccentric shaft, A.

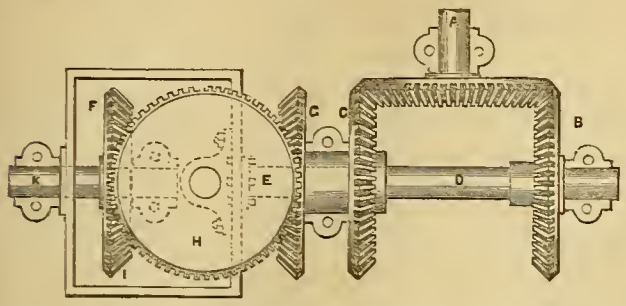
If the shaft is held stationary whilst the discs are caused to revolve upon it, the toothed disc, B, will make *twelve* revolutions in the time that the stud disc, C, makes *eleven*. Again, if the toothed disc is held whilst the shaft revolves twelve times, the stud disc will revolve once only in the same direction; and if the latter disc is held, the toothed disc will perform one revolution only in the contrary direction, for eleven revolutions of the shaft.

It is evident that almost any other relative number of revolutions may be produced by employing a disc with a suitable number of teeth, and another with the smallest number of pins (not fewer than three), which will not divide the number of teeth in the wheel. We have extracted this example of mechanism from the bulk of the reports of the British Association, in order to bring it more prominently forward in connection with the drawings of the combination, with which we have been obligingly favoured by Mr. Roberts. The principle of the arrangement is capable of most extensive modification, and we understand that Mr. Roberts is about to bring forward some very remarkable ones, bearing upon the applicability of the principle in practical matters.

We had laid before us, some time ago, a model of a combination of wheel work, invented twenty years ago, by William Thomson, a working engineer, when in pursuit of the faithless perpetual motion. The mistaken notion which led to its production was, that if a series of wheels of equal diameters could be made to produce an increase of speed, perpetual motion would result; for, with very plausible reasoning, the inventor argued, what is to prevent such a consummation, when, by the

mere combination of wheels (which are practically, levers) of equal powers, an accelerated movement is obtained?

Our engraving annexed will show that the plan is neither more nor less than a modification of the differential movement now universally



employed for the bobbin-motion in cotton-spinning; or, speaking with reference to their relative dates, that Mr. Houldsworth's beautiful invention is an applied example of the differential principle contained in the long-hidden model before us. A, Is the driving shaft, carrying a bevel wheel. gearing with two others, B and C. The former, B, is fast on the shaft, D, the extremity of which is bolted at E to the outside of a rectangular box frame, F, the opposite end of which is supported by a shaft in the line of the shaft, D. The bevel wheel, C, also driven by the first wheel, A, is connected by a long boss with the wheel, G, the two running loose npon the shaft, D, and being steadied by a supporting bearing. Motion is transmitted onwards from G, through the bevel wheel, H, which is fast on a short stud shaft running loose in a bearing carried by the interior of the box frame, F. I, Is the last wheel of the series; it is fast on the shaft, K, and is driven by the wheel, H, which, as will be observed from its position, has two motions—one round its own axis, the other round the axis of the line of shafting carrying the box frame.

The peculiarity of the scheme consists in the fact, that although the whole of the wheels are of the same size, yet *one* revolution of the driving shaft, A, will cause *three* of the driven shaft, K. By dissecting the various movements, the rationale of this will be easily seen. The box frame, F, primarily receives a motion equal to that of the driving shaft, through the wheel, B, and of course carries with it the wheel, H, which again receives a second motion from the first wheel, through the two connected wheels, C and G. Thus, the combined motions of the wheels, B and C, added to that of the box, F, result in a triplicate speed of the shaft, K; and by carrying on a similar series of wheels in connection with this shaft, the constant number, three, may be involved to any extent. The first series gives three; the second, nine; and the third, twenty-seven revolutions.—This production exemplifies in the strongest manner, the remarkable services which the search after perpetual motion has conferred npon machinery. Ingenious devices like this, contrived and formed to gain power, served only as elegant absorbers of it; of themselves they are useless, and in the hands of practical genius alone, do they become available for real service. A secret for upwards of twenty years, its contriver has derived neither profit or credit from it, and others have re-invented, and rewarded themselves for its introduction.

REFORM OF THE PATENT LAWS.

One of the closing transactions of the Parliamentary session just ended, has been the passing of an Act for the amendment of the Government routine of patents. The Act is intituled "An Act to regulate certain Offices in the Petty Bag in the High Court of Chancery, the Practice of the Common-Law Side of that Court, and the Enrolment Office of the said Court." We give below, the forty-four heads of the Act, recording at some length the more material portion of them.

Clause 1. Abolishes, after 1st January, 1849, the offices of the senior, second, and third clerks.

2. Clerk of the Petty Bag to be appointed, who is to execute his duties in person, except in case of sickness, &c., when he may appoint a deputy, with consent of the Master of the Rolls.

3. Appointment of first and other clerks of Petty Bag, who are to hold office during good behaviour, and on vacancy to be filled up by the Master of the Rolls.

4. Clerk of the Petty Bag to perform all the duties and be subject to all the regulations of the senior and other clerks, but not to be an attorney of the court.

5. Clerk of the Petty Bag not to act as attorney or solicitor.

6. Salary of clerk of Petty Bag £600, but may be increased in certain events to £800.

7. Clerk of Petty Bag may appoint such clerks to assist him as the Master of the Rolls may direct, who shall be paid by salary.

8. Salaries and expenses to be paid out of the suitors' fee fund.

9. Penalty on officers for taking gratuities, &c.

10. Power to Lord Chancellor and Master of the Rolls to regulate the transfer of business from time to time.

11. Seal of office to be provided and kept, and may be cancelled or altered from time to time.

12. Copies of documents sealed, to be admissible in evidence.

13. Writs, &c. issued out of Petty Bag office, to be sealed with the Chancery Common Law seal.

14. From and after the 1st day of January, 1849, *every* specification or instrument in writing for describing or ascertaining any invention, and to be enrolled in Chancery in pursuance of Letters Patent under the Great Seal, shall be enrolled in the Enrolment Office of the Court of Chancery; and *every* disclaimer and memorandum of alteration to be enrolled in pursuance of an Act passed in the sixth year of the reign of His late Majesty King William the Fourth, intitutled *An Act to Amend the Law touching Letters Patent for Inventions*, shall also be enrolled in the said Enrolment Office, and the enrolment of every such disclaimer and memorandum of alteration in the said Enrolment Office shall be and be deemed to be the enrolment thereof in the proper office, in pursuance of the provisions of the said Act. [At present a specification, or disclaimer, or memorandum of alteration, may be enrolled in any one of three different offices; and a seeker for information may have to search all three (paying fees to each) before he falls in with it.]

15. Seal to be provided for the Enrolment Office.

16. Certificates of enrolment to be given, and, when sealed, shall be admitted as evidence.

17. Every document or writing, sealed or stamped, or purporting or appearing to be sealed or stamped with the said seal of the Chancery Enrolment Office, and purporting to be a copy of any enrolment or other record, or of any other document or writing of any description whatsoever, including any drawings, maps, or plans, thereunto annexed or indorsed thereon, shall be deemed to be a true copy of such enrolment, record, document or writing, and of such drawing, map, or plan (if any) thereunto annexed, and shall, without further proof, be admissible and admitted in evidence, as well before either House of Parliament as also before any committee thereof, and also by and before all courts, tribunals, judges, justices, officers, and other persons whomsoever, in like manner and to the same extent and effect as the original enrolment, record, document, or writing, could or might be admissible or admitted in evidence, as well for the purpose of proving the contents of such enrolment, record, document, or writing, and the drawing, map, or plan (if any) thereunto annexed, and also proving such enrolment, record, document, or writing, to be an enrolment, record, document, or writing of, or belonging to the said Court of Chancery, and that such enrolment, record, document, or writing was made, acknowledged, prepared, filed, or entered on the day and at the time when the original enrolment, record, document, or writing shall purport to have been made, acknowledged, prepared, filed, or entered.

18. Punishment for forging or altering any seal or document.

19. Power to Lord Chancellor, &c., to fix a table of fees. And no fees to be taken in respect of duties performed at her Majesty's suit.

20. Clerk of Petty Bag to keep accounts of fees received, and pay the same into the suitors' fee fund.

21. Solicitors to be entitled to practise as attorneys in the Common-Law side of Chancery.

22. Writs may be tested in term-time or in vacation.

23. Writs may be made returnable in term-time or in vacation.

24. Proceedings of the court may be in either term-time or in vacation. Any writ of scire facias for repealing, cancelling, or vacating any letters patent or charter, which shall or may at any time hereafter be issued in any action at the suit of her Majesty, hereafter to be commenced, whether at the instance of any of her Majesty's subjects or otherwise, shall or may be directed and sent to the sheriff of *any county* in *England* or *Wales*, although the record upon which such writ shall be founded or issued may be or remain in the county of *Middlesex* or any other county, and that it shall not be necessary that any such writ which at any time hereafter may be issued and directed to the sheriff of any such county as aforesaid, shall be a testatum writ, or founded upon any previous writ directed or sent to the sheriff of *Middlesex* or any other county. [At present such cases can only be tried in the county of Middlesex.]

25. Prosecutors' names to be inserted in writs of scire facias.

26. Declarations, &c., in scire facias to be delivered, and not filed.
27. Pleas in scire facias to be delivered, and not filed.
28. Issues in scire facias may be tried in any of the superior courts. [At present they can be tried only in the Court of Queen's Bench.]
29. Issues upon traverses to be tried in like manner as issues in scire facias.
30. Record of issue to be filed in the office of the Petty Bag.
31. Costs to be taxed.
32. Writs and proceedings to be prepared by parties or their attorneys.
33. Judges may dispose of matters raising or incident to any action on the Common-Law side of the Court of Chancery.
34. Master of the Rolls may make orders for the custody, &c., of the records.
35. General rules and orders may be made.
36. Officers' privilege of suing abolished.
37. Proviso as to existing actions by or against officers.
38. Parties or attorneys to cause names to be entered in a book at the Petty Bag office.
39. Affidavits may be sworn before clerk of Petty Bag.
40. Saving of the jurisdiction of Lord Chancellor and Master of the Rolls.
41. Forms of writs to be settled and approved by Lord Chancellor, &c.
42. Courts of common law to take cognizance of writs.
43. Monies paid into court for her Majesty's use shall continue to be received as heretofore, &c.
44. Power to grant compensations, with consent of Treasury.

M'NAUGHT'S PATENT DOUBLE-CYLINDER MARINE-ENGINE.

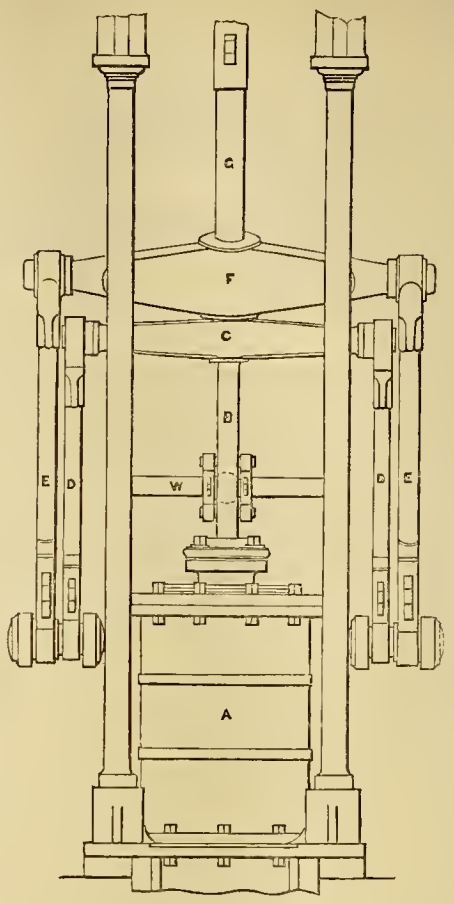
Illustrated by Plate 14.

Our previous pages have taken note of this invention as an auxiliary power for existing engines, where the extension of the works has rendered necessary a corresponding increase of labouring force. In place of erecting a new engine, adding a larger cylinder to the old one, or increasing the steam pressure to a dangerous height, a small cylinder is placed at the opposite end of the beam, and the steam is worked twice before it is finally condensed, thus adding materially to the original power. The example before us, in Plate 14, is a new engine throughout, and is the first erected in this part of the country. It was constructed by Messrs. J. and G. Thomson, of the Clyde Bank Foundry, in this city, for the flax-spinning works of John Fergus, Esq., M.P., at Prinlaws, in Fifeshire, and is worked in conjunction with a breast-water-wheel of 50 horse power. Our plate exhibits a complete side elevation of the engine, and a corresponding ground plan; and in the wood-cut below, is given an elevation of the high-pressure cylinder end down to the level of the sole-plate, all the views being drawn to the scale of $\frac{7}{16}$ of an inch to the foot.

The high-pressure cylinder, into which the steam is first conducted, is 22 inches diameter, and 4 feet stroke. It is represented at A, between the four wrought-iron columns supporting the crank-shaft, the position of which is analogous to that of the paddle-shaft of a marine-engine, the whole details of the engine being in fact identical with those of a marine-engine applied to stationary purposes. The high-pressure cylinder is cast with a circular flange near its centre, by which it is bolted to the sole-plate, through which a great portion of the cylinder projects. The system of connections for the crank, adopted for this cylinder, is identical with that devised some years ago by Mr. David Napier, as a direct action for marine-engines. It is clearly represented in the wood-cut of the end elevation. The piston-rod, B, carries a cross-head, C, to the extremities of which are jointed two short side-rods, D D, passing downwards to the joint-stud in the eyes of the side-levers, which are at this end made sufficiently wide to receive the two sets of side-rods, D D, and E E. The latter rods pass upwards to the larger cross-head, F, to the ends of which they are cottered, so as to form one piece with it, a short rod, G, being attached to the centre of the cross-head, and completing the connexion between the piston-rod and crank-pin. The side levers are of cast-iron, and are suspended in the usual manner upon the main centre passing through the condenser, H. Each lever works upon brasses adjustable by a pair of cotter keys passing through the lower side of the boss, and bearing against the bottom brass. The levers are retained in their exact position on the inner side by a shoulder on the main centre between the boss and the projecting eye on the condenser, and on the outside, a circular plate is screwed up against the boss by a screw passing into the end of the main centre.

The low-pressure cylinder, I, which is worked by the exhaust steam from the small cylinder, A, is bolted to the sole-plate at the opposite end of the side-levers, its fittings being in every respect similar to those of ordinary marine-engines. It is 33 inches diameter, and 4 feet stroke. The crank-shaft bearing is stayed by two wrought-iron stays, K, cottered into eyes cast on the inner ends of the crank-framing, and being attached to the upper inner edge of the cylinder by two eyes cast on the ends of the frames, L, attached at their extremities to the hot well and the cylinder.

The body of each of the pistons consists of a single hollow casting, with four radiating strengthening feathers. The packing is composed of two cast-iron rings, each with two cuts, and actuated by a series of U springs placed between the body of the piston and the interior surface of the rings. The cross-head, M, is attached to the top of the piston-rod by a central eye in the usual manner, and is adjustable by a nut bearing on the upper surface of the eye; from the ends of this cross-head the wrought-iron side-rods, N N, pass downwards to the joint studs in the double eyes of the side levers, where they are attached by straps and keys. The parallelism of the piston-rods is maintained by the arrangement of radius bars adopted in marine engines. The parallel motion shaft of the low-pressure cylinder is carried by a pair of short pillars, O O, passing through round eyes forged in the diagonal stays, K, and resting at their lower extremities upon the upper sides of the semicircular portions of the valve rocking shaft pedestals, P. This is a very neat and simple arrangement, the pillar acting as a lateral stay for the diagonal bars. The parallel motion shaft of the small cylinder is carried by bearings forged on the upper sides of two short diagonal stays, Q, which are fitted with round eyes at one end for passing upon the wrought-iron pillars of the crank framing, where they are supported by collars. The contrary ends are bolted to the pedestals, P, upon which eyes are cast for the purpose.



7-16ths

The air-pump, R, which is bolted to the sole-plate at a distance of 2 feet 9 inches from the main centre, is worked by short side rods attached to studs on the inner sides of the side levers; the cross-head being guided in a correct and simple manner by light wrought-iron guide rods bolted to the cover of the pump, and passing through eyes formed in the cross-head for the purpose, their upper ends being fixed in the short diagonal stays, Q. The condenser is of a rectangular section, and, together with the thoroughfare leading from the low-pressure cylinder, is cast in one piece with the sole-plate. An air-vessel is fitted on its top, and on each side is bolted a pedestal, P, for the rocking shaft of the valve motion. The valves are of the usual single cup species, similar to those used in locomotive engines; they are kept up to the face by slight bent springs attached to the interior of the steam-chests. They are worked by an eccentric on the crank shaft, the rod of which, S, is fitted with a plain gab and guard at the extremity, for the pin of the rocking lever, T, the detaching apparatus for throwing it out of gear being worked by a hand lever, U, on the end of a transverse shaft passing across the engine. The rocking lever, T, is double-ended, the eye at the lower end being jointed by a connecting link to a second lever, V, placed on the rocking shaft, W, carrying a lever for working the valve of the high-pressure cylinder. The main rocking shaft passes across the engine from back to front, and carries a short-toothed segment, placed just within the front pedestal. Near the end of this segment is placed a stud-pin, from which a rod passes to the lever, X, fast on the rocking shaft, Y, working in bearings in the frames, L, and carrying a lever at each end for giving motion to the cross-head of the low-pressure valve spindle, which is guided by vertical rods in the same manner as the air-

pnmp bncket. By tbis arrangement, the weight of one valve balances that of the other.

The governor is situated behind the higb-pressure cylinder, its spindle, *z*, being snpported in a footstep on the engine-house floor, and steadied at its upper end hy two wrought-iron stays, *a a*, attached to the crank shaft framing. The sliding-ring worked by the governor levers, is jointed to two light links, *b b*, passing up to a lever on the shaft, *c*, whence, hy a series of levers and connecting links, the motiou is communicated to the throttle valve, which is placed in the steam-pipe in front of the valve-chest of the high-pressure cylinder. The steam-pipe from the boiler, which is not shown in our plate, eouducts the steam by the thoroughfare, *d*, seen in the ground plan; a corresponding passage, *e*, conveys the exhaust steam by the dotted copper pipe, *f*, to tbe front of the valve-cbest of the low-pressure cylinder.

The hand gear for the valves consists of a quadruple lever, fast on a short spindle, carried in bearings on the top of the condenser. Upon the inner end of this spindle is a small pinion, gearing with the toothed segment on tbe main valve rocking shaft. By this means, when the eccentric-rod is thrown out of gear witb tbe rocking lever, hy the handle, U, the valves of each cylinder may be handled with great ease by the quadruple lever. The engine is holted down to a foundation of masonry hy twelve holts, four at the high-pressure cylinder, four at tbe main centre, and four at the low-pressure cylinder. Two cast-iron beams of tbe douhle L section, eight inches wide and six inches deep, are laid along the bottom of the masonry, in a longitudinal direction, and through these, tbe bolding-down bolts pass, thus binding the whole foundation together, and giving the sole-plate a firm hold. Two transverse beams of similar section are laid in the masonry, above the longitudinal ones, their ends being laid in the bottom of the two side walls of the engine-honse. By adopting this plau, a eonsiderahle saviug in depth of masonry is effected, and a most substantial hase is formed.

The action of the engine is identical in principle with that of the ordinary dnplex cylinder engine of Woolf, but the relative position of the two cylinders affects, to a very great extent, the economy and regularity of the expansive action of the steam, wbich may be here carried out to the utmost extent. The high-pressure steam aeting at one end of the side levers, is always balaneed hy that of the low-pressure and the vacuum in the larger eylinder, so that the eomhined power of tbe two is eouveyed to the crank-piu, as if from a single direct action cylinder.

Througb the polite attentions of George Wilson, Esq., of tbe Prinlaws works, we lately had the pleasure of inspeeting the engine in action, and of examining the general arrangements of the works, whieb are beautifully situated iu a valley elose to the village of Leslie, and about three miles from Loehleven, whose discharging waters turn the several water-wbeels of the establishment. The engine is placed alongside the main water-wbeel, through the house of whieb the crank-shaft of the engine passes to a ratebet-clutch in connection with the gearing of the wheel. From tbe water-wheel house, connections pass through the wall into the lowest room of the mill adjoining, for the purpose both of regulating the snpply of water to the wheel, and for throwing the engine into or out of gear by the ratchet-clutcb—drawing upon one or other—of tbe two prime movers as eireumstances may require.

The engine is nominally of 60 horse power, but, with its full pressure, 35 lhs. in the hoiler, it is eapable of being worked up to 120 horse power. We shall have more to say regarding the action of the engine next mouth, wben eugravings of the boiler will he given.

ON A MODIFICATION OF THE THEORIES OF REFRACTION AND REFLECTION OF LIGHT.

Some years ago, when occasionally reading the Treatises on Optics, pnhlished by the Society for the Diffusion of Useful Knowledge, I was led, with all due deference to the great philosophers whose attention has been engaged by this study, to entertain opinions very different from theirs. For a long period I had ceased to think further about the matter, until the *Practical Mechanic's Journal* fell into my hands, when my dormant thonghts were roused hy seeing there a series of papers bearing upon the point. Sometime about the year 1840, I heard a lecture on optics, illustrated by experiments, which made an extraordinary impression on my mind. The various and beautiful phenomena displayed were delightful, hut the way the lecturer tried to account for them was not satisfactory to my mind. I could not believe that one ray of light proceeding from the sun, or any artificial flame, could be different from anotber; that white light was composed of differently coloured rays, and tbat they were more or less susceptible of being refracted according to their colonr. I examined the heautiful experiments of the eminent Sir Isaac Newton, which led to his great optical discoveries, and was satisfied that bis conclusions could not be disputed, provided tbe laws of refraction and reflection, upon which all his deductions depended, were correct; but then a question presented itself—had the path of a ray of light, in passing through a prism, been accurately traced? The elongated form of the spectrum and other phenomena made me doubt very much that it had not.

The undulatory theory next engaged my attention. It made more complicated, what already seemed too much so. The objects ought to be attained by it is obvious enough, but is at variance with daily observation, which proves that light, or rather the something that causes light, moves in straight lines, when passing through a uniformly dense transparent medium, and when interrupted by a surface, the angle of reflection is equal to the angle of incidence, thus obeying the same laws which regulate the motion of a ball thrown against a wall. Vibration appeared quite unnecessary for producing such effects as these.

There were a few remarkable facts which I thought would lead to a solutiou of the difficulties, viz., the constant ratio of the sines of incidence and refraction. When a ray of light is transmitted perpendicularly to the surface of a transparent substance, it moves in a straight line, but in all other directions is bent in its course; at a certain inclination, an astonishing effect, called the polarization of light, is produced; and at another and greater inclination, it is totally reflected. Now, I conceived, when a ray got freely through a body in one direction, but was prevented in another, it followed, that the nearer a ray was to the perpendicular, the farther would it penetrate that body before it was deflected; and therefore, at all inclinations between the perpendicular, and the total reflection point, the points of deflection would vary in their distances from the surface. Following this idea, I found that if a line he drawn through the various points at which rays of light are refracted, it will form an arch of a circle. Figure 1 represents the usual way of explaining tbe refraction of light. In figure 2, make V C R equal to the

Fig. 1.

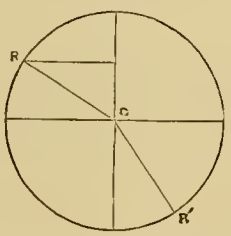
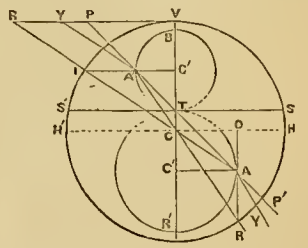


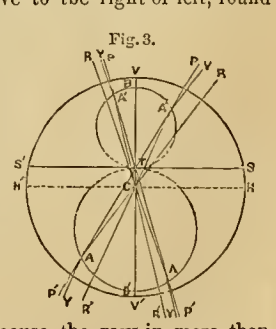
Fig. 2.



polarizing angle. Produce R C to A, a point in O R′, the cosine of the angle of refraction, V′ C R′; also produce R′ C to A′, a point in the sine, C′ I, of the angle of incidence, C′ C I. With A C″ drawn parallel to H N′, and A′ C′ as radii, describe respectively the circles, T B′ A, T B A′; and through T, where the circles touch one another, draw P P′, which will cut the circles in the points, A A′, and from A A′ draw A Y and A′Y′ respectively, parallel to C R′ and C R.

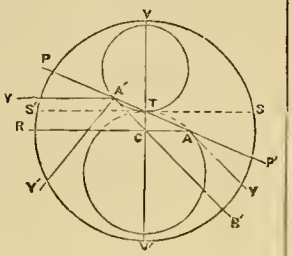
Suppose the upper and under parts of the figure to be air and glass, whose sines of incidence and refraction are as 2 to 3, and R C to be a ray of light moving in the direction, R C, it is not refracted as is generally supposed at C, and moves in the direction C R′, but it proceeds to A before being refracted, and then moves in the direction A Y, parallel to C R′. In the same manner, R C is not refracted at C, and moves in the direction C R, but it goes onward to A, and is then refracted, and passes in the direction A′ Y′, parallel to C R. Such is, I conceive, the manner in whieb a ray passing through air into glass, and one through glass into air, are refracted. The same description will apply to any other position of the rays, by supposing the line, P P′, to revolve to tbe right or left, round the point, T. See two positions in figure 3. It will cut the circles, T B′ A, T B A′, in two points, A A′, whieh are the points of refraction to two rays, R A, B′ A′, which pass through the eommon point, C, to meet A A′, and the direction of the rays after refraction are, A Y, parallel to C R′, and A′ Y′ parallel to C R. It will be found that the sines to the lines thus drawn in any position have the proper ratio, and that the rays after refraction, being parallel to their original directions, have the same ratio. It will be necessary to suppose P P′ the section of a plane, and the circles, T B′ A, T B A′, the sections of cylinders, because the rays in more than one plane are required to fill up the various points of the circles.

Fig. 3.



If P P′, supposed capable of revolving round T, be perpendicular to H H′, then R A, R′ A′, passing through C, to meet A A′, now at B B′, the greatest distances from the surfaces, all the lines will be in the position, V V′, and as no angles are formed by R A, R′ A′, and P P′, there is no refraction of the rays, but when P P′ recedes from V V′, to the right or left, as in figure 3, the refraction of the rays at first being very little, gradually increases as the angle, V T P or V′ T P′, enlarges, and when P P is inclined 45° to H H′, as in figure 2, R C V is the polarizing angle, A A′ being then at the extremities of the diameters of the circles in a horizontal position, and of course at the greatest distances from the perpendicular, V V′, which passes through C; P P′ continuing to revolve, A A will gradually return toward V V′, till, as in figure 4, they come to certain points in the circles, when R′ A′ is a tangent to the circle, T B A′, then A′ is the point of total reflection. Neither of the rays can in this position be refracted, because both the incident ray, R A, and the ray, A′ Y′, now reflected, would be parallel to the surfaces. Were it possible, then, A Y would, as shown before, be parallel to A R, and A Y a tangent to the circle, T B′ A, parallel to A′ R′. It will be observed that A A′ in any position, are equidistant from C, and that the four angles, P A′ Y′, T A′ C, T A C, P′ A Y, are equal to one another, so that really the angle of incidence is equal to the angle of reflection when a ray is transmitted, as well as when reflected, from a surface.

Fig. 4.



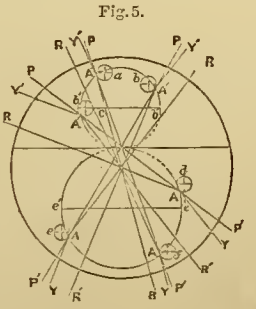
It is very probable that every mass of matter consists of spherical particles, not confusedly huddled together, but regularly and beautifully arranged in an infinite variety of forms; at all events, it is evident, in my opinion, that transparent bodies are so composed, otherwise refraction could not be performed so uniformly in every direction. For instance, if the particles of Iceland spar were of the same form as the crystal, it does not seem possible that the incident beam of light, at any given inclination to the axis, could be refracted exactly alike, during an entire revolution of the crystal. The particles I conceive to be disposed in rows along and parallel to the edges of the crystal, which, being oblique, produce double refraction. If the edges were right-angled, ordinary refraction would only ensue. I never had it in my power to examine a crystal, but, by making a model from a description of one, it appeared clear, from the particles being so much nearer to one another in the direction of the axis than perpendicular to it, that the rays would be refracted nearer to the surface; consequently, the indices would vary accordingly.

When two bodies have the same indices of refraction, the particles composing them being similarly arranged, rays of light pass through them the same as if they had been one body; but when there are more particles in a given space in the one than the other, the rows of particles and the spaces between them not being exactly opposite, some of the rays, when perpendicular, are not interrupted in their course, while others are; and opposite to the channels through which they are projected in other directions, are certain points of the particles, which make those that are transmitted deviate from a straight line, causing refraction, and the rest meeting the middle points of the particles are thrown back, causing reflection.

Although I have an idea of the relative positions and the number of the particles which make up the points of the circles brought under notice, yet, from not having devoted much attention to this part of the subject, I will defer an explanation till a future time. I will merely show, by placing particles in any position, how refraction is produced.

Let *a b c d e f* be particles (fig. 5), and R A, R′ A′, P P′, revolve as formerly, then P P′ will be a tangent to the particles at the various points, A A′, where the rays are refracted. These points are all in the under halves of the particles, beginning when the rays are nearly perpendicular, near to the extremities of their horizontal diameters, as at *a* and *f*, and gradually, as P P′ revolves, come nearer to the under extremities of the vertical diameters. At the polarizing angle, the points A A′, as at *b′* and *e′*, are just in the middle between the two, and if perpendiculars be drawn to P P′ from A A′, which will pass through their centres as in the other positions, they will be inclined as well as P P, formerly noticed, 45° to the line H H′.

Fig. 5.



In the densest body, the rays are refracted from the sides of the particles towards V V′, and in the rarest, from the sides away from the same line; thus making refraction towards the perpendicular in the one case, and from it in the other.

Between C A, C A′, in any position, but not in the same plane with those which produce refraction, are particles, the middle of which are opposed to the passage of a portion of the rays, thereby producing reflection. To find these points (fig. 7) draw D through the total-reflection point, and s s′ through T, both parallel to H H′, bisect the part of the line, V V′, lying between D D^1 and c^2, in the point c^4, also bisect C c^1 in the point c^3, and with radius c^1 c^3, draw the arch s c^1 s^1, and

Fig. 6.

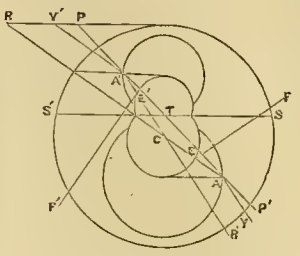
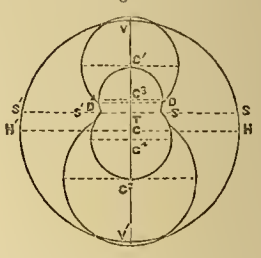


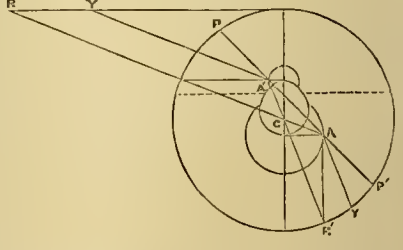
Fig. 7.



with radius c^4 c^2, draw the arch s c^2 s^1. These two arches will pass through the various points at which rays in any direction are reflected. In the case of refraction, we had P P revolving round a point forming a tangent to the particles; in the present case, it will be necessary to suppose a line forming a tangent to the particles at the points of reflection, to move parallel to H H′. At the polarizing angle, the reflected rays are perpendicular to those refracted, as in figure 6; R E and R′ E′ are the incident rays, and E F, E′ F, are reflected perpendicularly to A Y and A′ Y′ the refracted rays. s s′, Is properly the line where the two surfaces join, and not H H′, as generally supposed; therefore the point, C, through which the two rays pass, is always within the densest of the two bodies, and varies in its distance from the surface, according to the substances employed.

To show that these laws can be generally applied, I have added the 7th and 8th figures, whose sines are as 3 to 4, and 2 to 5, as in air to water and diamond.

Fig. 8.



These, however imperfectly expressed, are the laws which, in my opinion, regulate the refraction and reflection of light. The simplicity and harmony displayed in the operations of light are rendered intelligible, when viewed according to these laws, which is more than I can perceive in those which have hitherto been supported by the most distinguished philosophers.

From what has been stated, it must, I think, appear obvious, that there can be no difference between one ray of light and another, in regard to its properties. In order to explain it more fully (in my next paper, with your permission), I will show how the colours of the spectrum and those of natural bodies are produced. When I first heard that a body appeared of a certain colour, because it absorbed all the rays of a certain kind, and reflected the rest, I thought it the greatest among the many things which I supposed inconsistencies. W. M.

STEAM PROPELLER FOR THE FAN-BLOWER.

Since Mr. Ruthven's unsuccessful application of the rotatory emission engine of Hero, as a prime mover for agricultural purposes, the idea has been abandoned as impracticable, until a short time ago, when it was resuscitated for the purpose of driving circular saws for cutting railway bars. The great simplicity of its construction, its compactness, and withal cheapness of first cost, held out great inducements to parties requiring only a small amount of power; and accordingly, Mr. Ruthven some years ago erected a number of the engines for giving motion to thrashing machines, and the machinery of limited workshops. Soon, however, the purchasers found that great speed and great power were two very different things; an extravagant expenditure of steam began to manifest

itself, heavy and frequent repairs were required, and the experiment ended in the removal of the engines.

The operation of squaring off the ends of railway bars presented new ground for the employment of the emission principle, and in this case it has been most successful. The work performed by saws of this class is most irregular and trying, insomuch that it is injudicious to attempt it with the usual saw gearing, which is, besides, not always of convenient application. By placing an emission engine on the saw shaft, a direct acting power is obtained in a most simple manner, and any spare steam of the works may be economically applied in this way.

Another application which we now propose to describe, has been laid before us by Mr. Archibald M'Kechnie of this city. This is as a propeller for the fan-blast. Fig. 1 is a longitudinal section of the engine, as coupled to the driving spindle of a fan. Fig. 2 is an end elevation of the engine, with the side of the steam case removed.

The steam wheel, A, has four emission arms, which, together with the

Fig. 1.

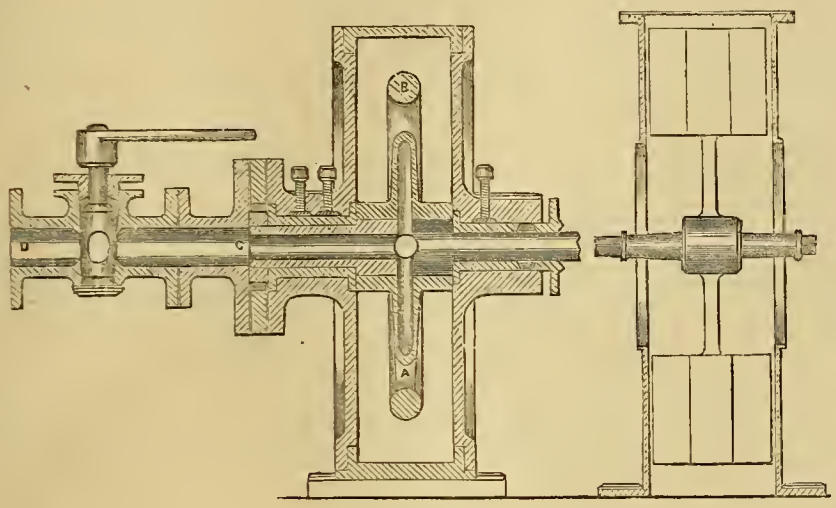
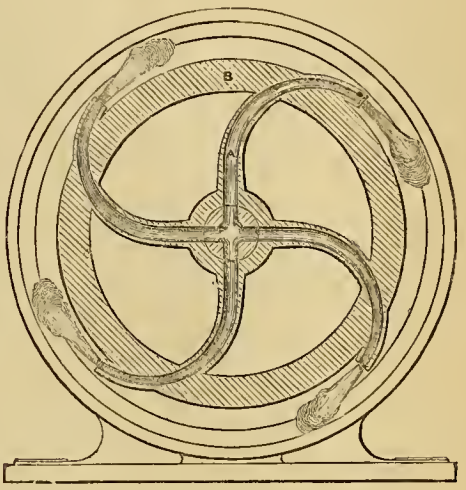


Fig. 2.



fly-wheel, B, are cast in one piece. It is provided with a long stout boss, by which it is keyed upon a wrought-iron shaft, made hollow at one end for the entrance of the steam. This boss fits close up at the ends between the sides of the case, where it abuts against the ends of the brasses of the steam-tight bearings, which are fitted into projecting necks, cast on each side of the case for the support of the wheel. The bearings are adjustable by set-screws fitted into the upper sides of the necks, and the main shaft is retained and adjusted laterally by a nut at C. The steam enters at D, by a cast-iron pipe bolted up to the flange of the neck; it then passes along the tubular portion of the shaft, and thence passes into the arms of the wheel through four holes, which meet the end of the tube.

The shaft may either be in one piece with the fan shaft, or it may be coupled to it in the usual manner, according to the locality. The exit opening for the air, in the fan case, is regulated by a hinged piece of sheet iron, worked by a lever and hand wheel, so that the size of opening may be accurately regulated in due proportions.

The objections usually brought against the ordinary fan-blast gearing, are many and weighty. A great many changes are necessary to get up the speed and prevent slipping; this leads to a great mass of shafts and connections, and inordinate friction results. Whether the plan before us will realize any economy in working, remains to be tried. It is of course only applicable where a steam pipe can be easily got at, and where the steam to drive it can be well spared. At any rate, it will afford a direct means of obtaining the great speed which the fan requires.

Unlike its application to sawing, the labouring force in the propulsion of a fan is continuous, and the consumption of steam would certainly be very great, perhaps sufficient to counterbalance the objectionable features of the ordinary system of driving. The enormous velocity of a jet of high-pressure steam, precludes the possibility of our obtaining its full dynamical effect on the emission principle. Suppose the steam pressure to be 60 lbs., then the jet openings should pass through a space of 160,000 feet per minute, to give out the full power due to this pressure so applied; for the steam should simply issue from the openings, without any appreciable force, all impulsive power retained in the jet after its escape being so much lost to the wheel. Such a rate of motion of the wheel is, of course, impracticable.

Mr. M'Kechnie's idea is not perfectly new, as we have seen a model fan driven directly from the shaft of a miniature rotatory engine. The engine was one of a novel construction, the invention of Mr. W. Gorman of this city, and was on the impulsive principle. The action of the arrangement was very good, but the consumption of steam is yet an open question.

Since we wrote these remarks, Mr. Nasmyth of Patricroft has informed us, that Captain Ericcson made a steam fan some years ago, at his works; we have no data as to the results of this trial. We shall further illustrate the subject next month, by an engraving of the steam-saw constructed by Mr. Nasmyth.

INDIAN IRON.

Not long ago, a statement appeared in the papers regarding the importation into this country of 100 tons of iron from China, and the seeming novelty of the transaction gave rise to many interesting speculations and surmises as to the success of such a venture. Our inquiries on the subject have resulted in the information that this iron was the production of the works of the Indian Iron and Steel Co. near Porto Novo, a seaport town on the coast of Coromandel. The consignment in question came in the character of ballast, and, instead of costing £4 a ton freight, the ships taking cotton from India to China, and bringing tea to England, are glad to get it under this condition, in place of paying for basaltic rock at Bombay, sand from the beach at Madras, or granite from China.

The original projector and chief upholder of this Iron Company was Mr. J. M. Heath, a gentleman well known for his valuable researches and discoveries in the manufacture of steel, now almost universally employed by steel-makers throughout Great Britain. The exertions of this gentleman, and those of the few who gave their assistance in the matter, as embodied in the history of the formation of the Company, exhibit a rare example of persevering labour, and possess features which, to the interested observer, appear almost to bear the impress of romance.

In the year 1818, Mr. Heath, then in the civil service of the East India Company, on the Madras establishment, was stationed in the district of Salem, and having heard by accident that the natives of Salem manufactured steel of very superior quality, and at a very cheap rate, he turned his attention to the subject, and found that, so far back as 1797, specimens of the metal had been sent to England; and in the year 1800, the celebrated David Mushet had thus given his opinion upon it:—"The possession of this ore for the fabrication of steel and bar iron, might to this country be an object of the highest importance. At present it is a subject of regret, that such a source of wealth cannot be annexed to its capital and talent. Were such an event practicable, then our East India Company might, in their own dominions, supply their stores with a valuable article, and at a much inferior price to anything sent from this country." An opinion like this, from so eminent an authority, interested Mr. Heath still further; and he had erected, a set of furnaces for smelting the ore, and for converting it into steel, similar to those used by the natives. In these furnaces a considerable quantity of bar iron,

and east steel in cakes, was manufactured in a manner superior to that practised by the natives. In fact, the iron was valued in this country at £20 per ton, and some of the steel, drawn into small bars, was purchased by Mr. Pepys of the Poultry for one shilling per pound, although it required to be melted and drawn down again under the hammer, before he could use it in the manufacture of fine cutlery.

By the processes at that time in use amongst the natives, ore containing 75 per cent. of iron did not yield more than 15 per cent. of bar iron, and four times the quantity of fuel used by Europeans was expended in the operations. It then became clear, that, in order to economize the material, the European system must be introduced; and, accordingly, resigning his appointment in the East India Company's Service, Mr. Heath visited this country for the purpose of obtaining practical information in the details of the manufacture. After various experiments, mingled with successes and failures, he returned to India; and finding that there were insurmountable objections to the establishment of works in the Salem district, owing to its unhealthiness, the difficulty of transport, and its distance from the sea-coast (150 miles), he fixed on Porto Novo, on the Coromandel coast, about 100 miles from Madras, as a suitable locality.

In August, 1830, two blast furnaces, a steam-engine, and a set of blowing apparatus, were erected there by workmen sent out from England; but it was not until 1833, that after an examination by a committee nominated by the governor of Madras, that an association, under the name of the "Indian Iron and Steel Company," was formed. After obtaining leases of different districts, and having surveyed the country to a great extent, Mr. Heath returned to Porto Novo in 1835, and then found, that owing to the difficulty of repairing steam machinery, it would be necessary to use cattle gins; but, on putting these up, it appeared that the power of Indian cattle had been overrated, and the machinery proved useless. The prejudices of the European blast-keepers still further retarded the operations, as these parties persisted in attempting to treat the Indian ore in the same manner as in England.

At the time of the erection of the furnaces, the calculations were that the yield per furnace would be 25 tons of pig iron per week; but in the beginning of the year 1840, it was discovered that the blast originally employed in three furnaces, would, when turned into one, and without any change in materials, produce 70 tons weekly, with a consumption of 23 cwt. of charcoal to a ton of iron, and a yield of 70 per cent. from the ore. As the main object at that time was the production of steel iron, it was determined to limit the operations in the charcoal refinery to the first stage—that of "blooms." This turned out to be an error, for the greater part of the converters in England having no concern with the manufacture of iron, few of them had the means of making the blooms into bars, so that iron in this state was unsaleable. Previous to this date, Mr. Heath having ascertained the powerful effects of a certain preparation of manganese, in improving the quality of cast steel, and cheapening its cost of production, he resolved to test the process on his arrival in England in 1838, and the discoveries then made, resulted in the valuable process to which we have before made reference. In 1838, Mr. David Mushet's process for obtaining malleable iron direct from ores of iron, which are free from earthy matter, was practically applied by Mr. H. N. Clay, who at this date took out a patent for a modification of the principle. This process was tried upon the Indian ore; and as a first experiment, about three tons of the prepared ore, deprived of its oxygen, were converted into steel at the Chelsea works, by cementation with carbonaceous matter at a high temperature. Cast steel made from this production was manufactured into swords, and dies for coining, in order to afford examples of its fitness for the most trying purposes.

Messrs. Sanderson, the eminent steel-makers of Sheffield, made a series of experiments in the year 1840, upon the Indian metal, according to the processes of Mr. Heath. The principle of one of these processes was the melting together of cast and malleable iron in certain proportions, producing cast steel; the other was to impart to cast steel the property of welding to iron, which is not possessed by cast steel as ordinarily made. As an example of the effects of the process, a cast-steel chisel, broken in the middle, was so well joined by welding, that the point of junction was only discoverable by a microscope.

One of the great drawbacks to the Indian manufacture of malleable iron, was the want of a cheap flaming fuel; and to supply this want, Mr. Heath proposed the adaptation of a gaseous in place of a solid fuel. His proposition was to the effect, that by adapting an apparatus to a blast furnace, the combustible gas—carbonic oxide—could be collected and applied to puddling, reheating, or raising steam; and subsequent practice shows, that the gas evolved from one blast furnace is sufficient to puddle the whole of the iron produced from it. The discovery of the convertibility of any description of carbonaceous matter into a gas, which, mixed with heated atmospheric air, is capable of producing, by ignition, a temperature sufficient for every operation in the manufacture of iron, has removed the immense disadvantage under which India formerly laboured. England's coal no longer gives her a monopoly in this respect, for the refuse wood of India supplies an excellent material for the production of carbonic oxide, the efficiency of which as a heat-producer has been fully proved.

Sometime ago another establishment was started, in a much more favourable locality than Porto Novo, and its product is now selling, in the shape of bar iron, for from £12 to £22 per ton, whilst English iron commands only £7 to £8. It is now proposed to form a joint stock company upon the foundation of the present association, so as to provide pecuniary means for the sufficient prosecution of the objects of the undertaking. The introduction of the railway system into the country will open up a path for the attainment of this object, but not till this period will the hopes of the projectors be realized.

BLACKBURN MARKET HOUSE.

Illustrated by Plates 15 *and* 16.

After submitting, from time immemorial, to the want of anything in the shape of a building for market purposes, the inhabitants of Blackburn have made a bold push to place their town in the same rank with others of its class, and have lately erected the very substantial and handsome building which forms the subject of two of our plates in the present number. In so large and busy a town as Blackburn, it may be easily conceived that something more than mere street stalls must be requisite for the due transaction of business connected with agricultural produce; but it was not until the year 1845 that a practical movement towards the amelioration of the evil was made, in the purchase, by the Improvement Commissioners, of land, from Joseph Feilden, Esq., the Lord of the Manor. To this gentleman the town must ever consider itself deeply indebted for his generosity in disposing of so convenient an area of ground, at a price quite unequal to its actual value.

The laudable system of offering premiums for designs for the building was, in this instance, liberally carried out; and the choice of the committee fell upon that of Mr. Terence Flanagan, engineer to the Bolton, Blackburn, Clitheroe, and West Yorkshire Railway. The circumstances connected with Mr. Flanagan's success are in the highest degree creditable to him as a professional man, and deserve the consideration of young designers, who may be diffident of their powers and qualifications. On the occasion of the opening of the building, he told the meeting, that when he sent in his design, he was a perfect stranger in the town; that he was not an architect, having never erected anything beyond a railway station; but, following the suggestion of a gentleman connected with a railway project in the town, he tried his hand, and succeeded in providing a design at once cheap, elegant, and well suited to the requirements of the place.

Plate 15 is a perspective view of the house, and Plate 16 is a transverse section of the roof, with detailed views of the girders, columns, and principals, and a complete plan of the building on a smaller scale. The dimensions of the building are 181 feet 6 inches, by 109 feet 6 inches, and the height inside, from the flagging to the springing of the roof, is 25 feet, and to the ridging, 34 feet 6 inches. The entrance doors are eight in number—three in each end, and one on each side, the whole being 10 feet wide, and 16 feet high, except the main central entrance beneath the tower, which is 12 feet wide. At the eastern end, and on the sides, the entrances are approached by flights of steps, with parapet walls, to compensate for the slope of the ground. Under the stairs are placed the entrances to the cellarage, which extends under one half of the area of the building. These cellars are arched over with brick, supported on cast-iron pillars and girders, so as to form a bed for the flagging of the house. Ranges of side windows furnish light to the cellars, and an additional supply is obtained by the adoption of the system in use for lighting ship cabins from the upper deck, and to this end rectangular blocks of plate glass are placed in iron frames, at regular intervals, in the flagging of the house. The house itself is lighted by ranges of two-light windows, each two feet wide, fourteen windows on each side, and six on each end.

Stone panels fill the lower parts of these windows, the light being admitted through transparent plate glass. Immediately over the windows an arcade surrounds the building, the ends of the arcade being filled with stone receding from the face of the pillars. The side arcades amount to 116 spaces, which are filled with plate glass. A plate glass louvre light, of six feet on each side, extends along the apex of the centre compartment of the roof, adding, in a very considerable degree, to the lightness of the interior. Above the arcade, on each of the six gables, is a rosace of seven feet diameter, glazed and louvred, acting in conjunction with the roof light as ventilators for the building.

The interior accommodations consist of a row of shops along each wall, the centre being occupied by stalls placed in rows of four, both longitudinally and transversely, forming 184 yards of stallage; the shops are thirty-four in number, thirty of which are fitted up with fire-places.

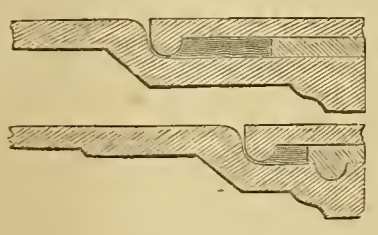
The tower, which is the main external feature of the building, is 18 feet square, and measures 90 feet from its base to the top of the pinnacle. It stands upon four pillars, arched over with 12 feet arches, forming entrances to the main central door. A committee-room occupies the lower portion of the tower, immediately above the supporting arches: it is accessible from the interior of the house by two flights of steps. The market-looker's office occupies the corresponding space opposite the staircase lobby. Over the committee-room, a space is provided for the reception of an illuminated clock, and above the clock chamber the market bell is hung. The top of the tower is completed by a cantilever cornice, surmounted by antefixæ, the whole terminating in a copper ball and short spire, with a vane.

The roof, as detailed in Plate 16, is divided into three spans, supported by the external walls; one of which is shown detached at A, and two rows of cast-iron columns, B B, eight in each row, dividing the building longitudinally into nine bays: see fig. 1. Fig. 2 is an elevation of one of the longitudinal girders, C; fig. 3 is a horizontal section of the column at E, showing the position of the girders and attachment of the principals; fig. 4 is a vertical section of the straight portion of the girder; fig. 5 is a horizontal section of the upper column at F, with the ends of the girders; fig. 6 is a half-size section of the principal, which is composed of timber with plate iron at the sides; and fig. 7 is a complete ground plan of the building, with the interior fittings of the shops and stalls.

The stone employed in the building is from the neighbouring quarries of Burnley, Longridge, and Pleasington, and is of a very fine colour. The cost of the whole works was about £8,000.

IMPROVEMENT IN PIPE SOCKETS.

The ordinary rule in the manufacture of pipes intended for the conveyance of water and other fluids, is to make the sockets from 4 to 4½ inches in depth, this amount being considered necessary for a good safe joint. The upper figure in the accompanying wood-cut, represents a half section of a 6-inch pipe socket of this size, as packed with yarn, held in its place by an external leaden ring. The lower one exhibits a modification suggested by Mr. Bowman of the Highfields Foundry, Staffordshire, whereby this great depth of socket is proposed to be avoided, and the spaces for the yarn and leaden ring considerably lessened, both being retained in a space of 2½ inches. In this plan, the yarn occupies only the small inner space, and the interior surface of the socket is formed with a semicircular groove all round, for the reception of a corresponding projection on the exterior surface of the leaden ring, so as to prevent its being forced out by any pressure from within.



1-4th.

The advantages of this modification, as detailed by Mr. Bowman, are—a saving of nearly 2½ per cent. in the weight of each pipe, the impossibility of the joint giving way, and the practicability of laying the pipes at greater angles, reducing the number of bends. The plan is worth trying, and appears to us to possess considerable superiority over the usual plain socket.

PIATTI'S COMPRESSED AIR RAILWAY SYSTEM.

In the heat of the controversy on the merits of the locomotive engine and atmospheric systems of railway propulsion, the backers of the latter would appear to have overlooked the chance of assisting their cause by the compression of the raw material they employ, in place of depending entirely upon the atmospheric weight. Now that the dispute has pretty nearly drawn to a close, the compression scheme has made its appearance, with what prospects we shall shortly see.

The arrangement which has come under our notice, is the invention of Mr. Piatti of Milan, and has been patented in this country by Messrs. Prosser and Carcano. A model experimental line has been laid down near Peckham, London, where a four-horse power Cambrian engine is at work as the prime mover for the subjugation of the air thus compelled to toil for man. The line is 150 yards in length, the guage being 18 inches. The traction tube is 2¼ inches bore, being of an area slightly less than 4 inches square. The propelling air is compressed into a reservoir up to 30 lbs. per square inch, and is allowed to exert its force upon the piston for about 48 yards only, the remainder, including 50 yards on an incline of 1 in 30, being travelled over by the carriage, which weighs 1 ton, by momentum alone.

The atmospheric tube is slotted throughout its entire length, as in Samuda's and other systems, and is furnished with an India-rubber valve shutting from within. Reservoirs are to be stationed at intervals along the line to be kept supplied with compressed air by stationary engines or water power.

Messrs. Prosser and Carcano claim for their scheme, innumerable advantages over the old vacuum system, and give a table explanatory of the relative advantages of the two in comparison with a locomotive line. Their averaged calculation of original cost of works and plant per mile is—locomotive, £30,000; vacuum, £16,500; compressed air, £13,500. Expense of working is relatively, £3,790, £2,175, and £1,525.

We are at a loss to know whence these calculations have been derived, as we have yet to learn that the atmospheric system has in any one instance outdone the locomotive in cheapness of working.

By the adoption of an internal closing valve, the greater the propelling pressure, the less chance is there of leakage; and, as far as it goes, there is an advantage on this head. Again, as there are theoretically no limits to the working pressure, a smaller propelling pipe may be used. Nevertheless our experiences of the practical working of the atmospheric system, are far from leading us to expect any valuable results from it, in whatever shape the idea may be carried out.

SMITH'S ELECTRO-PRINTING PROCESS FOR PORCELAIN.

We have much pleasure in stating, that Mr. Smith of Blackford has discovered a most valuable process for printing, colouring, and gilding porcelain and earthenware, by means of electricity. The devices hitherto produced in this manner are extremely beautiful, and the cost of production is diminished one-third. The process is quite distinct from that of the electrotype, or any other known method. We can at present do nothing more than notify the fact of the invention, but we shall take the earliest opportunity of publishing the whole of the details of it. A paper on the subject, from the pen of the inventor, will be read at an early day, before the Society of Arts, London.

THE MECHANIC'S LIBRARY.

Algebra, Examples in, 12mo., 2s. 6d. cloth, sewed. J. Wharton.
Churches of Scotland, Descriptive Notices of some, 7s. 6d.
Coal, Statistics of, illustrated, 8vo., 30s. cloth. R. C. Taylor.
Cyclopedia, The National, Vol. V., 8vo., 5s. cloth.
Engineer and Contractor's Pocket Book for 1849, 12mo., 6s., roan tuck. J. Weale
Geological Tales and Sketches, 4th ed., 12mo., 6s. cloth. M. Hack.
Inventions, On Letters Patent for, royal 8vo., 3s. 6d. cloth. Webster.
Inventors, London, Anecdotes, Part III., 18mo., 1s. sewed.
Light, Shade, &c., First Exercises in, square, 3s. 6d. cloth.
Oil Painting, Hand Book of Young Artists in, new edition, post 8vo., 8s. cloth.
Palace of Westminster, Part I., folio, 5s. sewed. C. Barry.
Railways, Treatise on the Construction of, 3d ed., 8s. cloth. J. Day.
Railway Practice, Second Series of, 2d ed., £2 12s. 6d. S. C. Brees.
Steam Engine, Tredgold on the, new ed., Part I., 2s. 6d. J. Weale.
Trigonometry, 4th ed. 8vo., 7s. 6d. cloth. Rev. J. G. Hall.

FRENCH MECHANICAL PERIODICALS.

A correspondent, who lately visited Paris, informs us that, as far as he could make out, the following is a list of the periodical publications relating to mechanics and the arts of production published in that city. The price given is the amount of a year's subscription for foreign parts, except where otherwise expressed:—

Annales des Mines [Mining Annals], 8o., plates. Appears every two months. 28 Francs per annum. Quai des Augustins, 39 and 41.

Annales des Ponts et Chaussées [Annals of Bridges and Highways], 8o., plates. Appears every two months. 28 Francs. Quai des Augustins, 39 and 41.

Archives des Deconvertes et des Inventions nouvelles [Memorials of Discoveries and New Inventions]. Appears at irregular intervals. 5 Francs a vol. Treuttel & Wurtz, Rue de Lille, 17.

Brevet d'Invention—Journal des Inventions Brevetes [Journal of Patent Inventions]. Monthly, 5 Francs. Boulevard St. Martin, 17.

L'Exposition Journal de l'Industrie et des Arts utiles [The Exposition, a Journal of Industry and the Useful Arts]. It publishes in the course of the year 288 engravings on steel, divided into six heads—architecture, furniture, bronze work and gilding, Parisian articles, carriage-building and horse furniture, machinery and mechanical implements. 24 Francs a year with the plates uncoloured, 48 Francs coloured. Place de la Bourse, 27.

Journal des Travaux de l'Academie de l'Industrie [Transactions of the Academy of Industry] Monthly. 2 Francs a number. Rue de Louis le Grand, 23.

Les Sciences utiles, Journal des applications à l'Agriculture, à l'Industrie, et à l'Hygiéne [The Useful Sciences, a Journal relating to Agriculture, Industrial Art, and Medicine]. Two numbers a month. 8 Francs. Rue de l'Ecole de Medicine, 10.

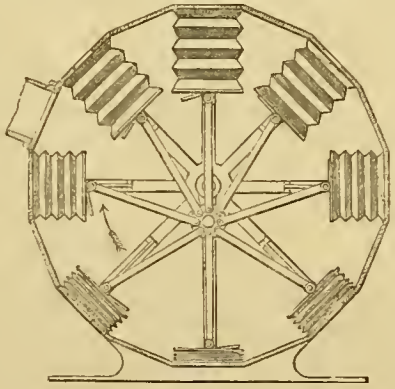
Technologiste ou Archives des progrès de l'Industrie Francaise et Etrangere [The Technologist, or Memorials of the progress of Industrial Art, French and Foreign]. 6o. 24 Francs. Hautefeuille, 10.

RECENT PATENT.

LLOYD'S BLOWING MACHINERY.

Mr. George Lloyd, iron-founder, of Stepney, has lately introduced some important modifications in blowing machinery, both as regards the fan and the cylinder blast. He remarks, in reference to the common fan—"That there must be always more or less of a vacuum formed behind each blade when revolving, and that the air which is condensed in front must rush over the ends and sides of the blades, to fill up the vacuum so formed, causing, no doubt, that disagreeable humming noise, which is common to all the ordinary fan-blowers, and absorbing a large portion of the power employed, for no better purpose than beating the air within the case." The fan, proposed as an amendment upon the usual form of construction, is fitted with a double case. The vanes are of a triangular shape, their tips approaching to a point. The inner case corresponds exactly to the shape of the vanes, and has a series of openings in its periphery for the discharge of the air into the external cylindrical case, whence it passes off by a discharge pipe in the usual manner. The vanes are six in number, and are considerably curved longitudinally, being set back at an angle of 60°. The object of the employment of a double case, with the peculiar shape of vanes, is to prevent the reflux of the air upon the latter; and, by narrowing the tips of the vanes to $\frac{1}{8}$ or $\frac{1}{12}$ of the width at the heel, less resistance is supposed to be offered to the escape of the air. The patentee shows a peculiar plan of bearing for the spindle, which our wood-cut will explain. A, Is the end of the spindle formed into a cone; B, is the fixed bearing, being a hollow cylinder, with its front edge bevelled internally to fit the cone; C, is a cylinder of plumbago, filling up the hollow of the bearing, and abutting against the conical end of the spindle, adjustment being obtained by an end screw, which forces forward a plug behind the plumbago.

The improvement in the cylinder blast possesses considerable novelty. The arrangement, as depicted below, consists of a series of cylindrical bellows placed round the interior of a hollow polygonal case, which forms the receiver for the air. Eight stationary arms radiate from a central boss, and are fastened at their outer extremities to the interior of the case. The outer extremities of these arms carry guides for the moving portions of the bellows, which are worked by a set of connecting rods attached at their inner ends to a metal disc fitting on the pin of a crank, upon the the driving-shaft passing through the centre of the case. In this way the revolution of the crank is continually acting upon the pairs of bellows, so as to preserve an almost perfect uniformity of blast. Each pair of bellows is fitted with a valve at its outer extremity, opening inwards for the influx of air, and a corresponding valve at the inner end discharges this air into the interior of the case, which thus acts as a large receiver, the air being discharged at an opening in the periphery.



Our readers will recognize in this scheme a similarity to the details of some of the late feathering paddles, where a revolving crank or eccentric ring acts upon each float-board as it comes to its dip in the water. In our sketch, the lowest pair of bellows is represented as completely collapsed and inert; the next on the revolving side is still blowing inwards, but has nearly completed its stroke. Each pair is contributing air to the case, as far as the top one, which is fully distended, and about to commence discharging; the remaining ones are receiving air, in readiness for acting as the crank approaches each individual one. Considerable ingenuity exists in this plan; and it is evident that its blast will be very nearly uniform, from the gradual action of each blower.

Patent dated March 8, 1848. *Specification enrolled September* 8, 1848.

REVIEWS OF NEW BOOKS.

SUPPLEMENT TO THE REPORT ON THE SUPPLY OF SURPLUS WATER TO MANCHESTER, SALFORD, AND STOCKPORT. By S. C. Homersham, C.E. London: Weale, 1848.

Mr. Homersham's Report has been pretty fully treated at page 110 of our August publication. The pages now before us are principally devoted to a reply to certain remarks upon this Report, which recently appeared in the *Manchester Times*. With altercations of this kind the public have little to do, and to one or two heads only can we here refer. The writer of the remarks in question, has stated that the rain guages erected by the Manchester, Sheffield, and Lincolnshire Railway Company, are "so constructed that there must inevitably be free evaporation; and when we remember that evaporation is more rapid, the higher the elevation, we have a ready explanation of the guages retaining less water on high than on low ground. So great is the error of these guages, that the quantity of rain indicated by them, as having fallen at Woodhead, is very considerably less than the quantity which is proved to have run off the ground." As a test of the accuracy of this statement, an open-mouthed phial, about three-fourths filled with water, was placed in the stand of a rain guage placed on high ground, and a similar phial was placed on a stand on lower ground. These phials were each 2½ inches in diameter, and had open necks ¾ inch diameter; the exact level of the water being marked on the outside. After standing three months, the level of the water was the same in each, proving that the loss charged against the guages in this respect is inappreciable.

In the appendix to the Supplement, Mr. Homersham quotes from a report "On the Well Waters of Glasgow," by Dr. R. D. Thomson, that "the quantity of matter dissolved, will depend in some measure upon the rapidity with which the water percolates, and upon the amount which passes through the strata; and hence we may expect, that in rainy weather, the solutions will be much more dilute, and that the constitution of the well waters may vary considerably at different seasons, just as we find that rivers contain much less solid matter in a given weight of these waters during rains, than during the dry season of the year."

With all deference to this opinion, which, it is to be observed, is brought forward in reference to Mr. Homersham's observations upon the purity of flood waters, commented on in our notice of his Report, we would submit that the question may be viewed under two aspects—for when rivers are very low, the impurities of the bed are certainly much greater in proportion to the bulk of water; again, when they are very high, owing to the reception of sudden land floods, the rush of water must carry away with it a vast proportion of foreign matter from the surface over which it passes.

The supplementary matter of the book closes with "an account of some observations made on the depth of rain which falls in the same localities, at different altitudes, in the hilly districts of Lancashire, Cheshire, and Derbyshire," lately read before the Royal Society by the author. According to the observations by J. F. Miller, Esq. of Whitehaven, the amount of rain falling in mountainous districts, *increases* from the valley upwards, to an altitude of 2,000 feet, where it reaches a maximum; and above this elevation the quantity rapidly decreases. This being directly contradictory to the received opinion, and the general experience of a great number of meteorological observers, Mr. Homersham has directed particular attention to the point, in order to reconcile the seeming discrepancy, by a comparison of the localities of observation. We shall close our remarks by an extract from his valuable deductions:—

"A knowledge of the facts before mentioned induced me to examine Mr. Miller's experiments soon after receiving them, with a view to ascertain how far they confirmed or were in opposition to the recorded observations and facts stated by the many eminent meteorological authorities before quoted, for which purpose I procured the best map of the lake district I could obtain, and marked upon it the situation of Mr. Miller's rain guages, and then compared together the results obtained by the rain guages placed in the valleys or the bottom of the hills, with the rain guages placed upon the tops of *the same hills* or bordering *the same valleys*. By proceeding with reference to locality in this manner, it soon became apparent that the valuable and interesting facts collected and recorded by Mr. Miller, with very few exceptions, which it appears to me may be easily accounted for, agreed with the observations of other meteorological writers. Indeed this could not fail to be the case, unless the generally received and admitted theory of the formation and distribution of rain, as laid down by Dr. Dalton, *was also disproved*.

"Upon examining Mr. Miller's facts, it will be found, from April to December, 1846, both inclusive, that at Whitehaven, 90 feet above the level of the sea, 38·063 inches fell; while at Round Close, 480 feet above the sea, and not far distant, only 36·195 inches fell in the same time; and during 1847, that 42·92 inches are recorded to have fallen at Whitehaven, and only 42·023 at Round Close.

"On examining with reference to locality in a similar manner the rain guages placed in the valley of Borrowdale, or Derwent Water, in which vale the quantity of water received by four rain guages at different altitudes are recorded by Mr. Miller, namely, one at Seathwaite, 242 feet above the sea; one at Sty Head, 1290 feet high; one at Seatoller, 1334 feet high; and one at Sparkling Tarn, 1906 feet high; it will be found, that from June 1846, to November 1847, inclusive, 193·63 inches fell at a level of 242 feet above the sea; at the greater elevation of 1290 feet, a less quantity, or 164·12 inches, fell; at the greater elevation still of 1334 feet, a yet smaller quantity, or 155·75 inches. The last

example, however, at an elevation of 1906 feet, shows that 183·47 inches fell in the same time, being, in this instance, less by 10 inches than the quantity which fell at the elevation of 242 feet, but much more than the quantities which fell at the elevations of 1290 and 1334 feet. This last fact I think may be accounted for by reference to the peculiar position of Sparkling Tarn (the mountain on which this last guage is fixed). This mountain is only 1906 feet high, but is in the *immediate* vicinity, that is, within a mile and a quarter to a mile and a half of the mountains Scawfell Pike and Bowfell to the south, and within a mile and a quarter of Great Gavel to the north. These mountains vary from 2900 to 3166 feet in height, the lowest of them being upwards of 1000 feet higher than Sparkling Tarn, while Sparkling Tarn is fully exposed to the westerly winds; and the clouds being carried inland by this wind, between the gorge formed by these high mountains, it may be easily conceived that a large portion of rain in the transit of the clouds would be deposited on the top of Sparkling Tarn; so that the large amount of rain falling at this altitude in this locality would appear to be the exception and not the rule.

"In the valley of Wast Water, the amount of rain falling at Wastdale, 166 feet above the level of the sea, from March 1846, to November 1847, both inclusive, is shown to be 170·55 inches; and at Scawfell Pike, which borders this valley to the east, 3166 feet high, only 128·15 inches fell in the same time.

"In the valley of Ennerdale, at Gillerthwaite, 286 feet above the sea, 133·86 inches fell: while at Great Gavel, 2925 feet high, during the same time, only 124·68 inches fell.

"All the valuable facts here alluded to, supplied by Mr. Miller with one exception only, prove that the greatest amount of rain falls in the same localities at or near the base of a hill, and not at so great an altitude as 2000 feet above the sea; and the one exception, namely, that at Sparkling Tarn, 1906 feet high, shows that, from June 1846, to November 1847, both inclusive, 183·47 inches fell; while at Seathwaite, the bottom of the valley, bounded by Sparkling Tarn, during the same time, as much as 193·69 inches fell, or 10 inches more at the lower than at the higher locality, thus confirming the conclusion arrived at by my observations, which also fully accord with the meteorological authorities I have quoted.

"As the amount or depth of rain falling in a given time in Great Britain, in different localities and under different circumstances, is a matter of very great practical importance to Civil Engineers generally, and especially to those engaged in designing works to supply large towns with water, to regulate the flow of rivers, or to drain large tracts of land, independent of their importance in a philosophical point of view, I have been unwilling to allow the valuable facts collected by Mr. Miller, with such perseverance and industry, to pass without a few comments, which, as it appears to me, may tend to make them more generally useful, by explaining their supposed discrepancy with the generally received views of such accurate observers as Dr. Dalton, Professor Daniell, Captain Lefroy, and the other authorities quoted in this paper, confirmed as the observations and recorded experiments of these last-named gentlemen are shown to be by the more recent experiments herein detailed."

Tredgold on the Steam-Engine: Its progressive and present state of Improvement; in divisions, practically and amply elucidating, in every detail, its modifications and applications, its duties and consumption of fuel; with an investigation of its principles, and the proportions of its parts for efficiency and strength. 4to. Plates. London: Weale, 1848.

The continuous progressions of improvement are yearly modifying, altering, and extending our scientific knowledge; and so gradually and silently is the change effected, that we know not its extent, until the records of the present and the past are actually contrasted. In no branch of science is this more distinctly evidenced, than in the practice of engineering. Whilst the theory of the steam-engine has stood almost unshaken since the days of Watt, the details of its practical construction may be said to have been fundamentally changed; for, as manufactures multiply, new applications of steam power, involving new constructive details, multiply also. Each successive modification adds something to the engineer's experience, but it is only by collecting, arranging, and classing these accumulations of information, that permanent good can result from them.

Looking to Mr. Weale's book as a promising storehouse of experienced facts, we have great pleasure in noting the appearance of the leading part, which relates to the management of the locomotive engine, and is from the pen of Mr. John Sewell. The 24 pages of the part are characterized by the greatest minuteness of detail, and, as far as they go, seem to leave nothing in the routine of the engine-driver and fire-man's duties to be guessed at. The various sections are divided into considerations of the qualifications of engine-drivers and fire-men—pay and conditions of service—duties of engine-men and fire-men—detonating signals for foggy weather—extra trains—luggage trains—repairing road—accidents—fogs—descending inclined planes—ascending inclines. The illustrations present two of the latest examples of locomotives, the "Iron Duke" eight-wheeled engine, and tender, of the Great Western Railway; and Mr. Crampton's eight-wheeled outside cylinder engine.

The technical nature of the matter in this part leaves little room for remark, and we shall defer further observations until the aim and true intent of the work is more clearly unfolded.

CORRESPONDENCE.

ENGINEERING LITERATURE.

In your pages of this month, you have an article purporting to consider the literature of engineering. The subject is, no doubt, one of importance, and deserves, therefore, to be properly understood. As for the article in question, though it displays considerable talent and acuteness, it is open to some exceptions, which, with your permission, I beg to offer.

The writer evidently aims at fine writing, and I willingly allow that he is usually successful; but, while ambitious to be fine, he should avoid the shoals of grandiloquence, on which he is apt to run aground, and the "attenuated thought" with which he so lustily charges periodical literature. In finding fault with some periodicals on account of the meagreness of their contents, or the wide range of subjects which they embrace, it should not have been forgotten, that the oldest professional periodical in existence, has opened its pages to the discussion of every subject under the sun. Nevertheless, there is not at this time a more popular magazine of the same class; and sure I am, that the diversity of its contents has been the principal reason of its popularity, combined, no doubt, with a certain editorial shrewdness and happy management. It is always assumed in the article in question, that engineers should be able to furnish all the information on which the writer sets so much value. I should like to understand what Stephenson or Miller can tell us about their bridges, any more than that they were schemed by the dozen in their offices, on good stout drawing paper, with a saving clause in the specifications, providing that the contractor shall secure a good foundation for the piers and abutments, and something more to the same effect? As usually happens, the engineer's name is the foremost in cases of merit; no praise is attributed to the contractor. I am convinced, however, that this important personage frequently deserves the greater meed of praise. We may even take the Ballochmyle bridge, mentioned by the writer, as an example. It is well enough to ask about the principles which determined Mr. Miller in choosing this means of crossing the ravine. After all, it resolves itself into a very simple question. A bridge is required across the ravine; it is desirable that there should be a clear water way; for this purpose, there must be no pier founded on the bed of the river; the span is too great to think of a timber bridge, therefore it must be of stone, in one large arch too—nay, an "unrivalled semicircular arch." These are all the principles about it. The drawing having been got up, the contractor gets a copy, and forthwith executes the bridge. Here it is that the pinch is felt. The contractors for the Ballochmyle bridge, Messrs. Ross and Mitchell, I believe, had to erect a stupendous centering, a mass of engineering itself, and of their own design; they had to render it as firm as a rock, to carry the huge arch stones, more easily drawn on paper than put in their place; they had to organize the labour they employed at the bridge, so as to render it available in the most efficient degree; they had to attend to a hundred other matters about which, certainly, the engineer never troubled himself, and which it is likely he never will hear of. The contractors, therefore, are entitled to a very great share of the reputation founded on such a magnificent work; and it is to them principally that the world should look for the elaborate treatises sought for. I wish merely to set the claims of contractors in a proper light. Engineers have plenty of scope for shining in their own spheres. As for the class denominated resident engineers, their merit, like that of military officers, consists in their doing their duty, which is to see that the work in course of construction is executed in a substantial and workmanlike manner. Of the inefficiency of some of our residents, we have had grievous examples; and had the Ballochmyle bridge, or many other such works, been in the hands of other than able and competent contractors, I doubt if it had been much the better or the worse for the inspection of a resident. Our resident engineers, as a class, are little better than learners or puppets; raw from the office, and as green as rushes. There are, no doubt, a select few, who have worked for their situations, and now fill them meritoriously, but the majority have sprung like mushrooms from the hot-bed of the past railway mania.

There is, unfortunately, but too much reason for the strictures indulged in by the writer, upon the ordinary application of mathematics to engineering. I think, however, it is not fair to discourage the study of mathematics, which at least is the tendency of the last part of the article. It may be true that we are not indebted directly to mathematical acquirements for many great inventions. There is not a doubt, however, that the tendency of mathematical studies, properly pursued, is to sharpen all the mental faculties, the inventive faculty amongst the number—and I do think, that a tendency so favourable should not be discouraged by any such innuendos as your talented article contains.

Glasgow, 15th Sept., 1848. C. E.

[To our correspondent is due at least the merit of sincerity, as, without any apparently interested motive, he criticises severely the profession to which, judging from his signature, he belongs. It is scarcely necessary for us to offer any comment upon his effusion, as it does not affect the main argument of the article of last month. We may pass over his opinion of the style of the composition with observing, that the aim at "fine writing," which he condescendingly notices, is a just and neces-

sary aim. Let us always aim at great and good things; the exercise, especially when "usually successful," is sure to expand the intellect and refine the feelings. The periodical to which C. E. refers forms no exception to the class of periodicals we had in view. Being issued at weekly intervals, it has a facility of adapting itself to and discussing every passing topic, while yet interesting to the public; and it very properly takes advantage of that feature in its publication. It thereby caters effectively for a large section of the reading public, who are ever on the look-out for novelties of every description. It is also true that that journal possesses merits of a more substantial description.

We still maintain that engineers are the orthodox sources whence practical treatises are to be looked for. Bridges may be got up by the dozen—or the score, it may be—which proves the extent, not the superficiality, of their labours. Contractors have enough to do to mind their own business of working out a plan set before them. No doubt, they are of necessity intimately conversant with all the details of the operation of bridge-building—which, by the way, is only one department of engineering; but contractors, on the whole, are, we fear, as incompetent to the task of literary labour as they are unaccustomed to it; and, as one of their number remarked on one occasion, he could get up a bridge, but he could not get up a speech. Engineers, on the contrary, are in general educated for the purpose not only of getting up drawings by the dozen, but also of canvassing the merits of different kinds of structures, which they have the best opportunities of doing, of advocating their plans before parliamentary committees, collecting evidence for the same, and of getting up reports, accounts, descriptions, and numerous other literary articles. We maintain, then, that, on this ground alone, the propriety of engineers undertaking the publication of their works is undoubted. But we may also refer to the resident engineers, a class whom C. E. affects to despise; and we affirm that they are the very individuals of all concerned with railways who are the best able, under the superintendence of their principals, to gather materials for publication. As it is their duty, it is also their interest, to pay their undivided attention to the progress of the works under their inspection. They are not quite so green as C. E. supposes. It is surprising what an amount of labour and thought they spare the principal engineer. No doubt, many of them have been little more than blushing youths: time, however, corrects this fault; and, as the tide of railway business recedes, the more incompetent residents must disappear.

As to the mathematics of engineering, it would be folly to *discourage* it. It is true that mathematical studies sharpen the intellect, and therefore they cannot be despised. Our words, fairly interpreted, cannot be construed into a discouragement of mathematical studies. We merely wish them to be kept in their place. Of course, we could not, in the compass of a short article, consider the subject in every bearing. So much by way of explanation.—Ed. P. M. J.]

PROBLEM BY MR. WALTERS.

Finding that your correspondent, Mr. Adley, has misunderstood the first question of my problem (see page 137), and having lately altered the same, I shall feel obliged if you will afford the readers of your Journal an opportunity of seeing the accompanying modifications and additions to the original notes. It will be observed, that your correspondent's remarks are only applicable to the second question, because he has only considered the effect arising from the said work being performed with different cylinders of equal length and weight, but of different diameters; whereas, for the first question it is necessary to determine the effect arising from the work being performed with different cylinders of equal length, but differing both in diameter and weight. Your correspondent has also considered the subject, as if P had not in every case a particular value depending upon the nature of the cylinder, road, and rate of motion; or, in other words, he has considered that P might be supposed to represent any power less than that required to roll the cylinder over the substance, whereas it is intended to represent the power required to roll the cylinder over the bare road.

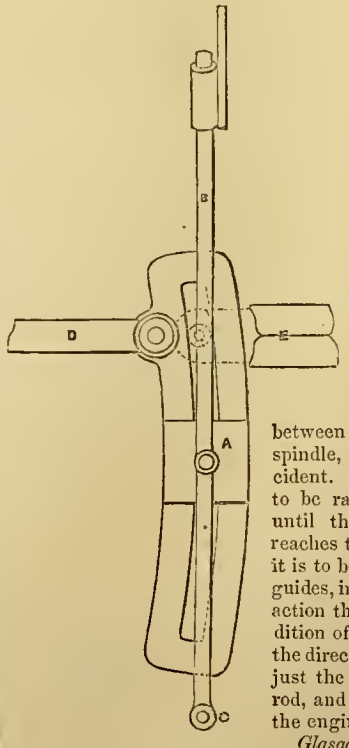
James Walters, Jun.

Guildhall Hotel, London, Sept. 16, 1848.

Note 1. In order to render the questions as perfect as possible, let moveable inclined planes be supposed to represent the said uniform substance; that is, instead of supposing the road to be covered with some uniform substance (a supposition that would be objectionable, because it would then be necessary to consider the friction that that substance would occasion to the surface of the cylinder while or after being crushed), suppose the road to be uniformly covered with moveable inclined planes, that were all of equal inclination and dimensions, and composed of the same material as the road itself (which suppose, for example, was iron), and so contrived that their upper surfaces would become parallel to the horizon when a certain pressure was produced thereon, each so by the same pressure (the inclined planes being supposed to be connected with such machinery as would cause them to resist any pressure less than a certain pressure on their upper surfaces without their original position being thereby altered; and also such, that when and after they were pressed down to their limit, they would have no tendency to regain their former position), and cause jointly as smooth a surface while the cylinder was passing over them as the road itself. Then moving those inclined planes to their limit, may be supposed to represent the crushing of the said substance.—*Note* 2. If the cylinder exceeded a certain weight, (that is, a certain weight whose value depended upon the power required to crush the substance), it would roll horizontally over the substance; because the centre of the cylinder would not in that case become vertical over any portion of the substance, until after such portion of it had become completely crushed.—*Note* 3. It will be observed, that the first question does not admit of being answered in the affirmative, unless a certain fundamental principle in mechanics (namely, "that what is gained in power is lost in time;" a principle that is supposed to be well established as the universal property of all machines), was, at the same time, determined to be untrue with respect to cylinders rolling over such moveable inclined planes as are here described. "The resistance to the motion of a carriage arising from dust or other comparatively small matter on the rails, which crushes under the wheels, increases as the square root of the cube of the weight upon its axles. The power required to overcome such resistance, is inversely as the radius of the wheel."—[See Tredgold's work on Railroads, page 44.]—Consequently, if the foregoing be true, the first question must be answered in the negative; because, if the same be true, it follows that the resistance to the motion of solid cylinders that are all of the same length and composed of the same material, and when rolled over any comparatively small substance that is crushed thereby, increases as the weight, or as the square of, the radius. Observe, when the same are rolled over the bare road, the resistance increases only as the radius, or as the square root of the weight. These conclusions, however, being determined by partly neglecting to consider the height of the substance crushed, (in consequence of the same being supposed to be insignificant when compared with the radius of the wheel), they are, therefore, if true, only partly applicable to the problem.

REVERSING LINK MOTION FOR A SINGLE ECCENTRIC.

The peculiarity of this link movement, is, that by it an engine may be reversed, and the degree of expansion varied for both directions of the engine's motion, without a backward eccentric. The link is constructed in the usual manner, but with the addition of a plate at A, carrying a central stud, upon which it oscillates. This stud is carried by a vertical rod, B, capable of a vertical movement through the guide at its upper end, and adjustable at any required vertical height, by a connection at C, communicating with the reversing lever. D, is the eccentric rod, and E is the connecting link for the valve spindle. In the present position of the link, it is supposed to be set for the forward direction, and is not in action, further than as a simple connection between the eccentric rod and the valve spindle, the two studs of which are coincident. To reverse, the vertical rod, B, is to be raised, carrying with it the link, until the lower extremity of the latter reaches the stud of the valve link, which, it is to be understood, is to be retained by guides, in a fixed horizontal position. This action then changes the link to the condition of a lever of the first order, making the direction of motion of the valve spindle, just the converse of that of the eccentric rod, and effecting a reverse movement of the engine.



R. M.

Glasgow, 18th Sept., 1848.

[The principle involved in the construction of this motion is not new. It was primarily proposed and applied as a reversing movement for marine engines, by Messrs. J. and C. Carmichael of Dundee, about thirty years ago. At this date, the "link" was not invented, and the "double fork," universally employed until its appearance, was adapted to work in connection with the studs on the ends of a double angular lever on the valve rocking shaft. Previous to the date to which we refer, it was argued that a single eccentric could not give a true action for both directions, and it is only by observing a specific relation between the lengths of the eccentric rod and the double lever, that the lead and lap is accounted for. R. M.'s sketch represents the link as inert, and to reverse, it must be lifted to such a height, that the eccentric rod, in revolving round the centre of the eccentric, shall have moved the end of the link with which it is connected, a distance equivalent to the lap and lead of the valve. The length of the eccentric rod will of course govern the amount of rise to be given to the link, as well as the length of the link. For, with a long rod, a long link and a great rise will be required; with a short rod, a short link and a diminished movement will give the proper angle. With the double fork of Messrs. Carmichael, no expansive action can be realized, because the forks are only in gear at each end of the double lever. With the link, adapted to their principle, expansion is available to the same extent as with the double eccentric link. But it is to be remembered, that where the lead and lap are great, the corresponding reversing angle may be inconvenient on the score of room.—*Ed. P. M. J.*]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—EIGHTEENTH MEETING.—SWANSEA, AUG. 9.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

President—Lord WROTTESLEY.
Vice-Presidents—The DEAN OF ELY, Rev. Dr. WHEWELL, Lord ADARE, Sir D. BREWSTER.
Secretaries—Dr. STEVELLY, Mr. G. G. STOKES.

"On a New Case of Interference of Light," by the Rev. Prof. Powell.—The principal experiment evincing this new kind of interference consists in placing a plate of glass, or other transparent substance, in a prismatic vessel containing a fluid (as, *e.g.* oil of sassafras or anise with plate or crown glass), so as to intercept the upper or thicker half of the prism; when the spectrum is seen covered with dark bands parallel to the edge of the prism, the number and breadth of which vary greatly with the refractive powers of the plate and medium, and with the thickness of the plate. In many combinations the plate must be inserted in the way just described, or towards one end of the spectrum, thus exhibiting an effect analogous to what was termed "polarity" in the experiments, by partial interception, of Sir D. Brewster, as in fig. 1. But for many combinations no bands are produced by this arrangement. In these cases, however, on placing the plate to intercept the thinner part of the prism, as in fig. 2, bands will be produced. This remarkable relation, as well as the number and character of the bands, can be all expressed by a formula derived from the simple interferenee theory: but for some more minute changes observed, recourse must be had to the diffraction theory, as in Mr. Airy's investigations, (Phil. Trans. 1840, 1841.) Those investigations have been pursued by Mr. Stokes of Pemb. Coll. Cambridge. When plates of doubly refracting crystal are employed, two sets of bands are seen superimposed even in those of the most feeble doubly refracting power, as quartz, &c. This may perhaps be serviceable to the mineralogist for detecting this property when very weak. In general, the number of bands observed in different cases agrees sufficiently well with calculation; and the method may be applied inversely for finding the refractive indices of one substance, the other being known. There is, also, a close analogy between these bands and those described by the Baron Von Wrede, though produced in a totally different manner.—(See Taylor's "For. Scientific Mem.," vol. I. part iii. p. 487.)

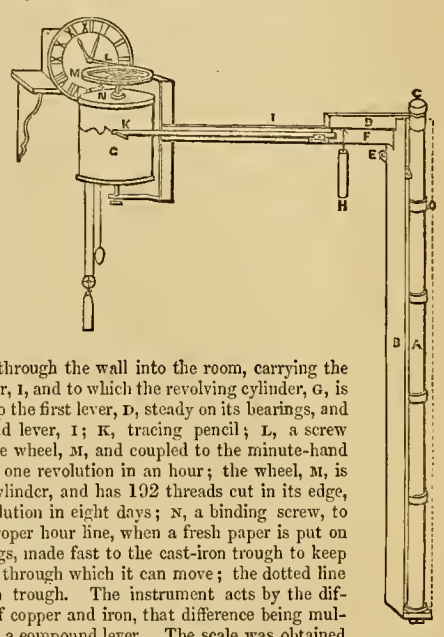
Fig. 1.

Fig 2.

Sir D. Brewster pointed out the circumstances under which the bands appeared and did not appear when the reflecting angle of the prism was turned to the red or to the blue end of the spectrum, as related to the refractive indices of the prism and the surrounding medium; which in his experiments was oil of cassia.

"On a Self-registering Thermometer, with twelve months' tracings of its work," by M. Harrison.—The principle on which the instrument acts, is the difference in the expansion and contraction of two metals, from the effects of heat and cold, and acting by the direct pull of the contracting metal when it is kept in a straight line. It is made sufficiently powerful to overcome any resistance which the fulcrums of the levers or the tracing pencil may cause. I have selected cast-iron and hard-rolled copper as the best suited for the purpose. I find, from tables published by Smeaton and others, that copper expands $\frac{1}{576}$ of its length, while cast-iron only expands $\frac{1}{779}$, with a variation of 180 degrees of Fahrenheit's thermometer, which leaves a difference of about the $\frac{1}{1260}$ of its length; and as the range of the thermometer in the shade in this climate is about 90 degrees, or half of 180, I have the $\frac{1}{2520}$ part of the length of the copper bar employed as a moving power. I fixed upon a bar 10 feet long as being a convenient length; the two metals will then vary nearly the $\frac{1}{50}$th parth of an inch between the hottest day in summer and the coldest day in winter. This variation I multiply by means of a compound lever, so as to get a sufficient scale to divide. The end of the last lever carries a pencil which traces upon a revolving cylinder the variations that take place. In order to divide the scale accurately, I procured a standard thermometer by Messrs. Troughton & Simms. I placed it in the same situation, and made several observations in the day, for some weeks, in the spring of the year, when the range of the thermometer is the greatest. After I had got the scale properly divided, I engraved it on a plate of copper, in order to get a number of copies printed. The only attendance the instrument now requires, is to put a fresh paper upon the cylinder, by means of stretching screws fixed on one side of the cylinder, once a week, when I wind the time-piece up.

Self-registering Thermometer.



A, Copper bar, one inch in diameter, and ten feet long; B, cast-iron trough, to which the copper bar is made fast at the bottom; C, brass cap soldered fast to the copper bar, with knife edges on the under side, which rest on the tubular end of the first lever, D, its fulcrum rests on the upper end of the cast-iron trough, B; E, flanges to bolt the trough to the outer side of a wall, near the angle of a room; F, part of the cast-iron trough which passes through the wall into the room, carrying the fulcrum of the second lever, I, and to which the revolving cylinder, G, is fixed; H, a weight to keep the first lever, D, steady on its bearings, and to counterpoise the second lever, I; K, tracing pencil; L, a screw working in the edge of the wheel, M, and coupled to the minute-hand of the time-piece, making one revolution in an hour; the wheel, M, is fixed to the axis of the cylinder, and has 192 threads cut in its edge, and would make one revolution in eight days; N, a binding screw, to adjust the pencil to the proper hour line, when a fresh paper is put on once a week; O, brass rings, made fast to the cast-iron trough to keep the copper bar steady, but through which it can move; the dotted line shows the side of the iron trough. The instrument acts by the difference in the expansion of copper and iron, that difference being multiplied about 120 times, by a compound lever. The scale was obtained by placing in the same situation a standard thermometer, by Messrs. Troughton and Simms, for several weeks in the spring of the year, when the range is the greatest, and making a great number of observations each day.

Tabulated results for the year 1847, *taken from tracings by the Instrument described.*

General mean of whole year	47·89
„ of January	36·61
„ of April	44·13
„ of July	61·80
„ of October	49·35
Highest single observation, 1st August	80·0
Lowest single observation, 13th February	22·0

Prof. Lloyd observed, that he much feared, as the indications of this thermometer were derived from the unequal expansion of different metals magnified by a system of levers, that the bearings of the levers would be found not to move continuously, but by starts.—Sir W. S. Harris thought it likely some correction would be required for the hygrometrical state of the paper on which the curves were traced, as well as for the effects of changes of temperature of other parts of the instrument.

Prof. Lloyd having been requested by several members to describe a barometer on a new principle which he had lately seen, said that it was a French invention. A cylinder of copper, with a very thin and corrugated end, was partially exhausted and hermetically sealed; and the effect of the varying pressure of the atmosphere on the thin end was magnified by a system of levers, so as to affect the index of a dial very little larger than a watch-dial. A friend of his had tested the indications of the instrument by placing it under the receiver of an air-pump, and observing its march in comparison with the indications of the long guage, and found them to agree to less than the $\frac{1}{100}$ of an inch.—Mr. Jenkins mentioned some remarkable cases of the discrepancy of the indications of a number of compared thermometers, ranged along a wall at short distances, and at intervals of a quarter of an hour.

"On the Refraction of Light beyond the Critical Angle," by G. G. Stokes, Esq.—The principal object in this communication was to give an expression, obtained from the undulatory theory of light, for the intensity of the central spot of Newton's rings when the angle of incidence exceeds the critical angle. It has been shown, by those who have treated the subject of reflection and refraction dynamically, that when the angle of incidence exceeds the critical angle, the expression for the disturbance in the second medium contains an exponential, involving the co-ordinate perpendicular to the surface, so that the disturbance is insensible at a distance from the surface of a small multiple of the length of a wave. The expressions for this superficial disturbance have not, however, so far as the author is aware, been hitherto

applied to the explanation of any phenomenon, although the existence of the central spot in Newton's rings has been unhesitatingly attributed to this cause by Dr. Lloyd in his Report on Physical Optics. The author has not entered into any particular dynamical theory, but has preferred deducing his results from Fresnel's expressions for the intensity of reflected and refracted polarized light, which, except perhaps in the case of very highly refracting substances, are, at least, a very near approximation to the truth. The method employed does not even render it necessary to enter into the question,—whether the vibrations of plane polarized light are in, or perpendicular to, the plane of polarization? When the angle of incidence exceeds the critical angle, Fresnel's expressions become imaginary; and by reasoning similar to that employed by Mr. O'Brien in interpreting those expressions in the case of reflected light, the author has arrived at formulæ for the reflected and refracted vibrations from whence he has obtained the expression for the reflected light. From this expression the author has deduced the following consequences:—1. At the point of contact there is absolute darkness, and on receding from that point the intensity increases; at first very slowly, so that for some distance round the centre the darkness is as to sense perfect; then the intensity increases more rapidly,—and then it very rapidly approaches its limiting value. This agrees with observation.—2. For different colours the same fraction of the incident light is reflected at points for which the radius, measured from the point of contact, varies as the square root of the length of a wave. Hence, the spot is larger for red light than for violet; but the separation of colours is small. This agrees with observation.—3. When the angle of incidence lies between the critical angle and a certain angle determined by a simple expression, the spot is larger for light polarized in a plane perpendicular to the plane of incidence, than for light polarized in the plane of incidence; while between the latter angle and 90° the reverse is the case. This difference of size agrees with observation; but it is impossible to say at what angle the changes take place.—4. Suppose internally incident light polarized at an azimuth of 45°, or thereabouts, and let the transmitted light be analyzed so as to darken the centre of the spot, then a faint ring of light ought to be seen separating the dark centre from the generally dark field of view. This ring ought to be bluish inside and reddish or brownish outside, and ought to vanish at the angle mentioned above. The author has not tried this experiment.

"An Examination of Berkeley's Theory of Vision," by Sir D. Brewster.—His attention was turned to this subject by having been called on to give a course of lectures on the Philosophy of the Senses. When preparing for this he was led most minutely to examine the well-known theory of vision by Bishop Berkeley, and made himself minutely acquainted with its details. He found, as he conceived, the fundamental principle on which the entire theory reposed defective. Berkeley's first proposition, which contained that principle, was, that direct distance from the eye had no linear representative in the image on the retina, and therefore that distance from the eye could not be a direct object of vision: now this first proposition Sir D. Brewster conceived to be false in fact, and therefore the entire theory which was founded on it must be abandoned. That there was a direct linear representative on the retina, even as seen by a single eye, he showed by a diagram to be the result of the rays entering the pupil; and let the pupil be of what size it may, unless reduced to an actual point, which it never can be, it must allow the rays to form an impression of the entire length of a line stretching away directly from the eye, and therefore objects do not appear all at the same distance from the eye, as would follow from the Bishop's theory. But further, Dr. Berkeley founded his entire theory on an assumed fact, which, if true at all, could be so only when one eye was alone used. Man is not an animal with but one eye. An infant obtains his first glances of the external world by opening on it both eyes; and from whatever source its lessons are derived, both eyes must be admitted to be equally efficient in the knowledge conveyed. In determining this question, he did not consider it essential to decide how single vision with two eyes was effected. It might be from the images falling on corresponding points of the retina—an opinion now exploded; or from the decussation of the filaments of the optic nerve—an opinion also exploded; or it might be the necessary result of the line of visible direction—as it certainly was. But wheresoever it originated, it was a fact which must be admitted. They had therefore to determine at what distance, and in what direction, a body would be seen by two eyes when seen single; a determination greatly facilitated by that beautiful instrument the stereoscope of his friend Prof. Wheatstone.—Sir David then, by reference to diagrams, explained how this determination was aided by the use of both eyes; and, in confirmation of his views, appealed to facts recorded by naturalists, to prove that the young of animals saw distances correctly almost at the instant of their birth. The duckling ran to the water almost as soon as it broke the shell. The young boa constrictor would involve and bite an object presented to it; and in like manner, no person ever saw a child use such motions as proved it to perceive objects at its eye, to grasp at the sun or moon or other inaccessible object, but quite the contrary. He also contended that the recorded cases of persons restored to sight by being couched for cataract, or having a pupil formed, led to a similar conclusion;—all of whom saw objects at a distance from the eye, and none supposed those objects to be upon the eye or within it.

Dr. Whewell, after expressing his strong sense of the general value and ingenuity of Sir D. Brewster's views, and his diligence of research, begged most respectfully to differ from him entirely in his conclusions. All the facts adduced by him were as well known to Berkeley, and to those who adopted and carried forward his views, as they were to Sir D. Brewster; and he could scarcely suppose that conclusions so firmly based upon facts, and harmonizing so completely with all that was known, would be overturned in a moment by a few well-turned sentences or ingenious popular deductions. As to those animals who were under the dominion of instinct, the question of how they at first were aided by their senses, as it was most intricate, so he conceived it could not be hoped to be disposed of in this summary manner; and many doubted whether it was not so mysterious in its operations as to leave the question of its final solution at any future period most doubtful. But as to man, he had little doubt that the most convincing proofs could be adduced that he required experience to guide him in the uses to which, at least in mature life, he applied his senses; although he admitted, that in infancy something resembling the instinct of other animals was to be observed. But if Sir D. Brewster had persuaded himself that infants, or even persons restored to sight at a mature age, could see the distances and directions of objects directly without any aid from experience, all he could assure him of was, that there were many others fully capable of forming a sound judgment, who, after the most patient and attentive consideration of facts, had arrived at a very different conclusion.—Mr. Estin, surgeon and oculist of Bristol, must beg to confirm the views enforced by Dr. Whewell. He gave several instances of persons whom he had restored to sight from total blindness, who, previous to experience, could form no idea whatever of the distances, or directions, or shapes of bodies; and in one instance, the patient for a length of time was in the habit of shutting the eyes entirely and feeling the objects, in order to get rid of the confusion which this circumstance gave rise to. But as her experience grew more perfect, she saw with increasing correctness and pleasure, until at length her sight became perfect.

Section B.—Chemical Science, including its Application to Agriculture and the Arts.

President—R. Phillips.

Vice-Presidents—Mr. W. R. Grove, Dr. Faraday, Dr. Percy, J. D. Llewelyn.

"Report on Colouring Matters," by Dr. E. Schunck.—Having referred to the six substances which were discovered in the infusion of madder roots, and described in the last report, the author announces the discovery of a seventh. The continued investigation of the subject has led to the conclusion, that there is but one colouring matter in madder, *i. e.* the Alizarin; and that the substance which was thought to be a colouring matter, viz., Rubiacin, is not so. The seven substances found in the brown precipitate from the madder infusion are Alizarin, Rubiacin, Alpha-resin, Beta-resin, Rubian, Pectic Acid, and Oxidized Extractive. The examination of the fluid was next made, and found to contain Xanthic acid and madder yellow. It has also been proved that madder contains sugar; but as the process by which this is separated is somewhat tedious, we must refer chemists to the report itself. It is known that after madder has been employed for dyeing, it still contains colouring matter, and that the article garanceux is manufactured from this. By treating this substance with boiling muriatic acid, it was found to contain lime, magnesia, oxalate of lime, phosphate of lime, alumina, and per-oxide of iron. After these salts were separated, boiling water extracted a large quantity of colouring matter, which would dye mordanted cloth quite full, and of the same colour as madder itself, thus showing that it contains alizarin. Alizarin is found to be composed of

Carbon	56·97
Hydrogen	4·19
Oxygen	38·84

—or, in fact, of carbonic acid and water. Alizaric acid is formed by treating alizarin with concentrated per-salts of iron or nitric acid. The salts of this acid are mostly soluble. Alizarate of lime is prepared by neutralizing alizaric acid with carbonate of lime, and evaporating to crystalization. It crystalizes in prisms possessing great brilliancy. Alizarate of baryta, prepared in the same way by means of carbonate of baryta, crystalizes in silky needles. Alizarate of silver, prepared by double decomposition, is soluble in boiling water, from which it crystalizes as the solution cools. Alizarate of lead is insoluble. By subjecting alizaric acid to heat, it is volatilized, and forms a sublimate in the shape of long white needles, to which the name of pyro-alizaric acid is given. By the solution in water, pyro-alizaric acid appears to be again converted into alizaric acid. Rubiacin was found to be C31, H9, O10, and Rubiacic acid, C31, H9, O16. Alpha and Beta Resin were next examined, as were also the other constituents; and the author then proceeded to examine the part which each material plays in the process of dyeing: from which it is satisfactorily proved, that alizarin is the substance producing colour; and the advantages of converting madder into garancin consists in removing the resins and those bodies which are not only useless but injurious, and in separating alizarin from those salts with which it is in the madder root in close combination.

"Report of Progress in the Investigation of the Action of Carbonic Acid on the Growth of Plants allied to those of the Coal Formations," by Mr. R. Hunt.—This investigation was assigned to the charge of a committee; and two sets of experiments have been established,—one by Dr. Daubeny at Oxford, and the other by Mr. Hunt, upon Ferns which have been supplied from the Royal Botanic Gardens at Kew. The arrangements are such, that two sets of these plants, belonging to the same class, are made to grow under the same circumstances, except that one set is supplied with measured quantities of carbonic acid. Numerous preliminary experiments had to be made, and several sets of plants have been destroyed in the progress of these. No general result can be announced beyond the fact, that the plants, by being gradually inured to the agency of the carbonic acid, can be made to bear a greater quantity than when a large per centage is given to them at once. The experiments must be continued over a long period before any decided result can be arrived at.

A discussion ensued, in which Dr. Faraday, Prof. Grove, Dr. Lyon Playfair, and others joined. The importance of the investigation was pointed out; but the uncertainty of the results, and the difference between the condition of the plants in nature, and when confined in close vessels, were particularly insisted on—and the necessity for a more enlarged system of observation was argued. It was also thought advisable, as these experiments were to determine the question of the conditions of vegetation during the carboniferous period, that the influence of carbonic acid upon animal life, particularly on those classes of reptiles which are allied to the great saurians, should be observed.

"On a Galvanometer," by Mr. W. S. Ward.—This was a modified form of an instrument exhibited at Southampton, in which the coil through which the electric current passes was made to move by the repulsion of a permanent magnet. The coil had fixed upon it, and at right angles to the direction of the wires, a small beam to which scales were attached. The weights required in the scales to bring back the deflected beam to its zero point, were the measure of the current passing along the wires.

"On the Action of the Red, Orange, and Yellow Rays upon Iodized and Bromo-iodized Silver Plates, after they have been affected by Daylight, and other Phenomena of Photography," by M. Claudet.—It was shown by MM. E. Becquerel and Gaudin, that a photographic image on a Daguerreotype plate might be developed by the action of the light which permeates yellow and red glasses, without the aid of mercurial vapour. M. Claudet has been continuing his researches on this point, and he confirms those results in a very striking manner. Numerous specimens were exhibited, in which it was shown that the powers of the so-called *continuating rays* in developing the image were not much inferior to the mercurial vapour—presenting a positive image like it, but differing from it in the tint by which it is suffused. M. Claudet suspects that this result is owing to the decomposition of the iodide and bromo-iodide of silver by the least refrangible rays, and that the whites are represented by finely divided silver in the place of mercury. The rate of action when the chemical agency permeates these coloured media, is infinitely reduced for these preparations; but still it is evident, that some of the photographic principle permeates them—and also, that these rays which correspond in colour with those media have a peculiar scale of action of their own.

"On the Influence of Light in Preventing Chemical Action," by Mr. R. Hunt.—Bearing on the same subject as that brought forward by M. Claudet (although differing, inasmuch as one set of experiments were made upon iodized silver plates, and the other upon iodized photographic paper), this subject was taken by the Section before any discussion was allowed on the preceding communication. Mr. Hunt having called attention to several experiments, in which certain luminous rays had been found to protect photographic agents from chemical change—particularly in the researches of Sir John Herschel—proceeded to describe his own experimental investigation of this subject. Taking a piece of highly sensitive photographic paper, which would blacken in a few seconds by the light of an argand gas-burner, he threw upon it a condensed spectrum which had been previously analyzed by a peculiar yellow medium—and then, by means of a mirror, reflected the strong light of the sun upon the paper. It was therefore under the influence of the unaltered reflected radiations, and also of the spectrum, from which the chemical agency had been as nearly as possible separated. The result was, that the paper was blackened over every part except that portion upon which the strong line of spectral light fell, which was protected from change *and preserved as a white band* in the midst of the darkened paper. This experiment was thought by the author strongly confirmatory of the view which he had taken, that actinism, or the chemical principle, and light, so far from being identical, are opposed in action to each other.

"On the Advantageous Use made of the Gaseous Escape from the Blast Furnaces of Ystalyfera," by Mr. J. Palmer Budd.—This communication drew attention to an economical application of the heated gases which are usually allowed to escape from the top of the iron furnaces. It appears that the gases which are evolved from these furnaces escape at a temperature which is about the melting point of brass. In the iron-works at Ystalyfera, where the iron is smelted by the use of anthracite coal, advantage has been taken of this in a most ingenious manner. By an arrangement, which is in its character exceedingly simple, but somewhat difficult to describe without a model (Mr. Budd's description was illustrated by a very nicely constructed one), the hot gas is led off into another channel by means of a strong current generated through a chamber and air-way from a point just below the top of the iron furnace. It is conducted, very little heat being lost in the passage, under the boiler of a steam-engine; and it is found to be at a sufficiently high temperature to heat the boiler without the consumption of any fuel whatever. Hence an immense saving is effected. Although only one furnace and one boiler has hitherto been adapted to this purpose, it is found to effect a saving of £350 a-year. We may consequently expect, that when the experiment is further extended, and more of the furnaces so arranged that this heat may be economized and employed for the numerous useful purposes to which it is applicable in a large establishment, the saving will amount to many thousands annually.—This communication is to be printed entire in the Transactions.

"Analysis of Wrought Iron produced by Cementation from Cast Iron," by Prof. Miller.—It is to be noticed, that considerable change in the specific gravity occurred in the iron after cementation: it was forged, and then found to have increased in density; the brittle iron had a specific gravity of 7·684, the malleable 7·718. The results of analysis were briefly these:—The quantity both of carbon and silicon are materially diminished by the cementation, though still the proportion of both is materially greater than in good bar iron. It also appears that the portion of carbon which is insoluble in acids is partly the same both before and after the iron has been rendered malleable, the diminution being confined almost to that portion of carbon which was chemically combined with the metal, and which, therefore, would be in a state for propagation through the mass more readily by cementation.

"On the Peculiar Cooling Effects of Hydrogen and its Compounds in Cases of Voltaic Ignition," by W. R. Grove, Esq.—This communication was illustrated by an experiment, in which it was shown that a platina wire, rendered incandescent by a voltaic current, was cooled far below the point of incandescence when immersed in an atmosphere of hydrogen gas. This remarkable cooling property of hydrogen, of course, became the subject of experimental examination in comparison with other gaseous media. By a very ingenious arrangement, tubes containing coils of platina wire were filled with hydrogen and other gases, and then, being plunged into water in which delicate thermometers were placed, the wires were traversed by the same current from the battery, and it was found that the water was always more heated in a given time by the wire in the tubes of oxygen, nitrogen, carbonic acid, carburetted hydrogen, &c., than by that in the tube containing pure hydrogen. It became necessary now to ascertain the cause of this peculiar phenomenon of hydrogen. It was found not to be due to specific heat, nor to the conducting powers of the gases. Convection did not explain the fact; and considerable difficulty was found upon examination to exist, if it was attempted to refer it to the greater mobility of the particles of hydrogen gas, the lightest known, than of either oxygen, nitrogen, or carbonic acid. It was found that this peculiar property also belonged, but to a less extent, to all the compounds of hydrogen and carbon.

A discussion followed, in which Dr. Williams, Col. York, Prof. Graham, and Mr. Hunt joined. Prof. Graham mentioned the curious fact observed by him in his researches on the diffusion of gases, that the hydro-carbons move through tubes with great velocity, and that ether vapour, which is four times the density of hydrogen, moves, notwithstanding its weight, at four times the rate of other gases. It was thought this would, perhaps, serve to indicate the path in which an explanation might be looked for.—Mr. Hunt drew attention to the fact observed by Prof. Graham, that ether vapour had the power of preventing the combustion of phosphuretted hydrogen, and of destroying the luminosity of phosphorus; and thought the phenomenon observed by Mr. Grove connected itself in some way with these curious properties of the hydro-carbons.

"On a Peculiar Property of Coke," by Mr. J. Nasmyth.—The following interesting fact was discovered some years ago, and it appears to furnish additional evidence as to the identity of the diamond with carbon, namely, that coke is possessed of one of the most remarkable properties of the diamond, in so far as it has the property of *cutting glass*. I use the term "cutting" with all due consideration—in contra-distinction to the property of scratching, which is possessed by all bodies that are harder than glass. The *cut* produced by coke is a perfect clear diamond-like cut, so clean and perfect as to exhibit the most beautiful prismatic colours, owing to the perfection of the incision. Coke hitherto has been considered as a soft substance, doubtless from the ease with which a mass of it can be crushed and pulverized; but it will be found that the minute plate-formed crystals, of which a mass of coke is composed, are *intensely hard*, and, as before said, are possessed of the remarkable property of *cutting* glass. This discovery of the extreme "diamond-like" hardness of the particles of coke, will no doubt prove of value in many processes in the arts, as well as interesting in a purely scientific sense.

In a conversation which ensued, it was stated by Mr. Chance of Birmingham, that in all probability the knowledge of this fact would lead to a saving of nearly £400 a-year in their establishment alone.

"On the Chemical Character of Steel," by Mr. Nasmyth.—Were we to assume, as our standard of the importance of any investigation, the relation which the subject of it bears to the progress of civilization, there is no one which would reach higher than that which refers to the subject of steel, seeing that it is to our possession of the art of producing that inestimable material that we owe nearly the whole of the arts. I am desirous of contributing a few ideas on the subject, with a view to our arriving at more distinct knowledge as to what (in a chemical sense) steel is, and so lay the true basis for improvement in the process of its manufacture. It may be proper to name that steel is formed by surrounding bars of wrought iron, with charcoal placed in fire-brick troughs, from which air is excluded, and keeping the iron bars and charcoal in contact, and at a full red heat for several days: at the end of which time the iron bars are found to be converted into steel. What is the nature of the change which the iron has undergone we have no certain knowledge; the ordinary explanation is, that the iron has absorbed and combined with a portion of the charcoal or carbon, and has in consequence been converted into a carburet of iron. But it has ever been a mystery that, on analysis, so very minute and questionable a portion of carbon is exhibited. It appears that the grand error in the above view of the subject consists in our not duly understanding the nature of the change which carbon undergoes in its combination with iron in the formation of steel. Those who are familiar with the process of the conversion of iron into steel, must have observed the remarkable change in the outward aspect of the bars of iron after their conversion, namely, that they are covered with blisters. These blisters indicate the evolution of a very elastic gas, which is set free from the carbon in the act of its combination with the iron. I have the strongest reasons to think, that these blisters are the result of the decomposition of the carbon, whose metallic base enters into union with the iron, and forms with it *an alloy*, while the other component element of the carbon is given forth, and so produces in its escape the blisters in question. On this assumption we come to a very interesting question—What is the nature of this gas? In order to examine this, all that is requisite is to fill a wrought-iron retort with a mixture of pure carbon and iron filings, subject it to a long-continued red heat, and receive the evolved gas over mercury. Having obtained the gas in question in this manner, then permit a piece of polished steel to come in contact with this gas, and in all probability we shall then have *reproduced* on the surface of the steel a coat of carbon resulting from the re-union of its two elements, namely, that of the metallic base of the carbon then existing in the steel, with the, as yet, unknown gas; thus synthetically, as well as by analytic process, eliminating the true nature of steel, and that of the elements or components of carbon.

"Report on the Air and Water of Towns," by Dr. Smith.—In commencing his report the author says, it has long been believed that the air and the water have the most important influence on our own health,—and superstitions have therefore constantly attached themselves to receptacles of the one and emanations of the other. The town has always been found to differ from the country: this general feeling is a more decisive experiment than any that can be made in a laboratory. The author proceeds to examine all the sources from which the air or the water can be contaminated. The various manufactures of large towns, the necessary condi-

tions to which the inhabitants are subjected, and the deteriorating influences of man himself are explained. If air be passed through water, a certain amount of the organic matter poured off from the lungs is to be detected in it. By continuing this experiment for three months, Dr. Smith detected sulphuric acid, chlorine, and a substance resembling impure albumen. These substances are constantly being condensed upon cold bodies, and in a warm atmosphere the albuminous matter very soon putrefies and emits disagreeable odours. The changes which this substance undergoes by oxidation, &c. is next examined—and shown to give rise to carbonic acid, ammonia, sulphuretted hydrogen, and probably other gases. The ammonia generated fortunately from the same sources as the sulphuretted hydrogen materially modifies its influences. The consequences of the varying pressure of the atmosphere have been observed; and it is shown that the exhalations of sewers, &c. are poured out in abundance from every outlet when the barometric pressure is lowered. By collecting the moisture of a crowded room by means of cold glasses, and also dew in the open air, it was found that one was thick, oily, and smelling of perspiration, capable of decomposition and production of animalcules and confervæ, but the dew beautifully clear and limpid. Large quantities of rain-water have frequently been collected and examined by Dr. Smith; and he says—I am now satisfied that dust really comes down with the purest rain, and that it is simply coal ashes. No doubt this accounts for the quantity of sulphites and chlorides in the rain, and for the soot, which are the chief ingredients. The rain is also often alkaline—arising probably from the ammonia of the burnt coal, which is no doubt a valuable agent for neutralizing the sulphuric acid so often found. The rain-water of Manchester is about 2½° of hardness; harder, in fact, than the water from the neighbouring hills which the town intends to use. This can only arise from the ingredients obtained in the town atmosphere. But the most curious point is the fact, that organic matter is never absent, although the rain be continued for whole days. The state of the air is closely connected with that of the water; what the air contains the water may absorb, what the water has dissolved or absorbed it may give out to the air. The enormous quantity of impure matter filtering from all parts of a large town into its many natural and artificial outlets, does at first view present us with a terrible picture of our underground sources of water. But when we examine the soil of a town, we do not find the state of matters to present that exaggerated character which we might suppose. The sand at the Chelsea Waterworks contains only 1·43 per cent. of organic matter after being used for weeks. In 1827, Liebig found nitrates in twelve wells in Giessen, but none in wells two or three hundred yards from the town. Dr. Smith has examined thirty wells in Manchester, and he finds nitrates in them all. Many contained a surprising quantity, and were very nauseous. The examination of various wells in the metropolis showed the constant formation of nitric acid; and in many wells an enormous quantity was detected. It was discovered that all organic matter, in filtrating through the soil, was very rapidly oxidized. The presence of the nitrates in the London water prevents the formation of any vegetable matter—no vegetation can be detected, even by a microscope, after a long period. The Thames water has been examined from near its source to the metropolis, and an increasing amount of impurity detected. In the summary to this Report, Dr. Smith states that the pollution of air in crowded rooms is really owing to organic matter, and not merely carbonic acid—that all the water of great towns contains organic matter—that water purifies itself from organic matter in various ways, but particularly by converting it into nitrates—that water can never stand long with advantage unless on a large scale, and should be used when collected or as soon as filtered.

Section G.—Mechanical Science.

President—The Rev. Prof. Walker.

Vice-Presidents.—Messrs. J. Glyn, J. Scott Russell, J. Taylor.

Secretaries.—Messrs. R. A. Le Mesurier, W. P. Struve.

J. Glyn, Esq. read a paper "On Hydraulic Pressure Engines,"—in which he called the attention of the members to a mode of employing the power of waterfalls in a most useful and important manner—too long neglected in this country, considering the advantages it affords in hilly districts for the drainage of mines. He brought under their notice the means of employing high falls of water to produce a reciprocating motion by means of a "pressure-engine." The pressure-engine acted by the power of a descending column of water upon the piston of a cylinder to give motion to pumps for raising water to a different level, or to produce a reciprocating motion for other purposes. The pressure-engine was calculated to give great mechanical effect in cases where waterfalls may be found of much too great a height, and too small a quantity to be practically brought to bear in a sufficient degree on waterwheels within the ordinary limits of diameter. The author produced instances of the desired pressure-engine, one of which was constructed about forty years ago in Derbyshire—and which he believed was still at work in the Alport Mines, to which it was removed from its original situation. The cylinder was, he believed, 30 inches in diameter. In 1841, Mr. John Taylor advised the application of another and more powerful engine at the Alport Mines, which was made under his (Mr. Glyn's) direction at the Butterby Ironworks in Derbyshire. This was the most powerful engine that had been made. The cylinder was 50 inches in diameter, and the stroke 10 feet. It was worked by a column of water of 132 feet in height, so that the proportion of power to act on it was as the area of a piston to that of the plunger—namely, 1,963 to 1,385, or fully 70 per cent. The superintendent of the machinery assured him that the engine had never cost them £12 a-year since it was erected. Its usual speed was about 5 strokes per minute; but it was capable of working at 7 strokes per minute without any concussion in the descending column, the duty actually done being equal to 163 horse-power:—Area of plunge, 9·621 feet × 10 feet × 7 strokes = 673·41. 673·41 × 62·5 × 132 = $\frac{5555632}{33000}$ = 163 horse-power. The author concluded by remarking, that, in this case as in all others when water acts by its gravity or pressure, those machines do the best work when the water enters the machine without shock or impulse, and quits it without velocity. They thereby obtain all the available power that the water will yield with the least loss of effect; and this result is best accomplished by making the pipes and passages of sufficient and ample size to prevent acceleration of the hydrostatic column.

Mr. F. Wishaw read a paper "On the Velocentimeter," with its applications.—He stated that, in the year 1837, he was engaged in working the general survey of the railways in Great Britain and Ireland; and that he invented the first velocentimeter for the purpose of testing more readily, than by the ordinary watch furnished with a second hand, the time occupied in passing over measured distances, which were usually marked by posts or standards. He now exhibited an improved instrument which resembled a handsome chronometer, and observed that it had tabulated thousands of miles without being out the hundredth part of a minute. He stated that by it, with the assistance of the electric telegraph, the time of the United Kingdom could be made uniform to half a second.

"On the Ventilation of Collieries, with a Description of a New Mine Ventilator," by W. P. Struve.—Mr. Struve proposed to substitute for the present system of furnaces a ventilator worked by a five horse-power engine, calculated to take out of a mine an unlimited quantity of air. This he does by converting the whole area of the upcast pit into an air-channel, which he connects with his ventilator by means of a culvert of a similar size. The ventilator consists of two large air chambers, something like gasometers, which he causes to move up and down in water contained in a tank constructed of masonry; the chambers balance each other, and are surrounded with outside cases so as to form double pumps: the inlet and outlet valves, when open, present the same amount of area for the ingress and egress of the air as the upcast pit, so that the only resistance to be overcome in ventilating the mine is what arises from the friction of the air in the passages of the mine, and in the parts of the apparatus, which would be of small amount. He described one now erecting on this principle at the Eagle's Bush Colliery, calculated to pass through that mine 40,000 cubic feet per minute, the cost of which would be about £4,000.

Mr. Whishaw read a paper, giving an Explanation of the various Applications of Gutta Percha, numerous specimens of which, in the shape of thread, cord, tubular staves, driving bands, constables' staves, sticks, whips, inkstands, medallions, shields, water buckets, stereotype plates, and almost every other description of article, both useful and ornamental, were present. The paper, after stating that gutta percha was the concrete juice of a large tree of the same name, abounding in Borneo, &c., obtained by tapping the tree periodically by the Malays, stated that its introduction into this country was purely accidental, Dr. Montgomery having transmitted the first sample of it to the Society of Arts in 1843, at which time he (Mr. Whishaw) was secretary to that Society. The first articles of use made of gutta percha in this country were laid before the Society of Arts in 1844, and consisted of a lathe-band, a short length of pipe, and a bottle-case, which he had himself made by hand, having caused the concrete substance to become sufficiently plastic by immersing it in hot water. He also produced casts from medals, which attracted considerable attention at the time, and surgical instruments were soon after made of this new material. It was also adapted to commercial uses; and from the period mentioned to July 11 in the present year, between 600 and 700 tons had been imported for the Gutta Percha Company. From 20 to 60 tons were now regularly imported every month. Contrary to the general opinion that gutta percha is a simple, hydrogenous substance, Mr. Crane, chemist to the Gutta Percha Company, found it in its ordinary state to consist of at least two distinct materials, besides a notable proportion of sulphur—viz. 1. A white matter, gutta percha in its pure state; 2. A substance of a dark-brown colour. Various experiments were made to ascertain its strength when mixed with other matters, and also as to what pigments would mix with it without rendering it brittle or deteriorating its qualities. From these it appeared that the only pigments that could altogether be relied on to be used with gutta percha, were orange lead, rose pink, red lead, vermilion, Dutch pink, yellow ochre, and orange chrome. Under the influence of heat and pressure, gutta percha would spread to a certain extent, and more so if mixed with foreign matters. All the mixtures composed of gutta percha and other substances which had been subjected to experiment, except that containing plumbago, were found to increase its power of conducting heat; but in its pure state gutta percha was an excellent non-conductor of electricity. The best composition for increasing the pliability of gutta percha was that formed in conjunction with caoutchouc tar, and next in order that of its own tar; and the best material at present known for moulding and embodying was obtained by mixing gutta percha with its own tar and lamp-black. In describing the process of manufacturing gutta percha, the author observed, that rude blocks of the material were first cut into slices, by means of a cutting machine formed of a circular iron plate of about five feet in diameter, in which there are three radical slots furnished with as many knives or blades. The blocks are placed in an inclined shoot, so as to present one end to the operation of the cutters. The slices are then placed in a wooden tank, containing hot water, in which they are left to soak until found in a plastic state. They are afterwards passed through a mincing cylinder, similar to that used in paper mills for the conversion of rags into pulp, and then thoroughly cleansed in cold water tanks; the water, in cases of impure gutta percha, being mixed with a solution of common soda or chloride of lime. It is next put into a masticating machine, such as is used in the manufacture of caoutchouc, and then pressed through rollers; thus being converted into sheets of various width and thickness. When necessary, the sheets are again masticated, and again passed through rollers. These sheets are subsequently cut into boards by vertical knives, placed at the further end of the table, along which the sheets are carried by a cloth or web to another roller, round which they pass, and are cut into the required widths. The bands or straps are then removed, and coiled up ready for use. Driving bands for machinery are thus made, and shoe soles and heels are

stamped ont of similar sheets of gutta pereha. In making tnbes or pipes, either of gutta percha or any of its compounds, a mass of gutta pereha, after being thoroughly masticated, is placed in a metal cylinder furnished with a similar piston, by which it is pressed down into an air box, kept hot with steam, which has at its lower end a number of perforations, through which the plastic material is forced into a cup, whence it passes out, round a core, into the desired tubular form, and thence through a guage to the required size, and into a receiver of cold water, being drawn to the other end of a long trough by a cord passing round a pulley at the far end of the trough, and returning to the person in attendance on the machine, who gradually draws the pipe away from the air machine. Thus tubes of considerable length and diameter are made to a very great extent, and are used for the conveyance of water and other liquids, and are now under test for the conveyance of gas. The paper next explained the variety of articles already made of gutta pereha, which were of three classes—1. Useful; 2. Ornamental; and 3. Useful and Ornamental combined. Various articles were then exhibited, including two very handsome shields, and a spleudid communion dish and service.—Mr. Whishaw next exhibited the Telakouphanon, or speaking-trumpet; and in doing so, said that speaking tubes of gutta percha were quite new. as was also the means of calling attention hy them of the person at a distance, which was accomplished by the insertion of a whistle, which, being blown, sounded at the other end quite shrilly. Attention having beeu thus obtained, you remove the whistle, and, by simply whispering, the voice would be conveyed quite audibly for a distance of at least three quarters of a mile, and a conversation kept. It must be obvious how useful these telegraphs must become in large manufactories; and, indeed, in private houses they might quite supersede the use of bells, as they were so very cheap, and hy branch pipes could be conveyed to different rooms; and indeed, if there were no electric telegraphs, they might, by a person being stationed at the end of each tube of three quarters of a mile or a mile, be made most speedily to convey intelligence for any distance. In private houses the whistle need not be used, bnt a more musical sound could he produced. He then amused the auditors by causing the end of the tube, which was of the length of 100 feet, to be inserted into the mouth-piece of a flute held in a person's hand, regulated the notes, and placing his own mouth to the other end of the tube, "God save the Queen" was played at a distance of 100 feet from the person giving the flute breath. Turning to the Bishop of St. David's, he said that, in the event of a clergyman having three livings, he might, hy the aid of three of these tubes, preach the same sermon in three different churches at the same time.—Mr. Whishaw also exhibited the gutta percha submarine rope or telegraph, which consisted of a tube perforated with a series of small tubes, for the conveyance of telegraphic wire, and which, for the purpose of preventing its being acted upon hy sea-water or marine insects, was banded or braided round hy a small rope, and its being perfectly air-tight would render it quite impervious to the atmosphere.

Mr. Scott Russell read a paper "On the Improvements which have been made in Steam Navigation," which he explained by appropriate diagrams.—The first great improvement that had been made was in the boilers. Formerly, the boiler flues were constructed of great length, so that the smoke was kept winding round and round in the flues, and at last was allowed to escape with difficulty. Now, however, they had adopted the plan of getting as much fire as possible in the shortest space of time,—and this had been accomplished by imitating as nearly as they could the locomotive engine boiler, by having tubes of thin metal which would evaporate a much greater quantity of water in the same time as flues of the usual thickness; now, also, instead of taking the smoke a long dance, as in the old fashion, they used short flues of four to six feet in length, and by having a great many of as thin metal as possible they heated the greatest quantity of water, and had the additional advantage of keeping the metal cool,—in consequence of which, a boiler of smaller extent and surface was of much greater efficiency with less weight of metal. The next point of improvement was in the engine; in the construction of which, however, there had been less change than in other matters. The former beam engine had been changed for the direct action engine, which was of various kinds; but the greatest change which had been made within the last ten years consisted in the employment of greater quantities of wrought iron in the construction of the engines, instead of the mass of cast iron formerly used. This was the only great change, for the newest Halifax steamers were still fitted up with the old-fashioned or lever engines. The next improvement consisted in working steam expansively to a much greater extent than heretofore. It was only within the last ten years that they had adopted this principle: the effect of which was, that instead of completely filling the cylinder with steam, they filled only to the extent of one-fourth—a volume of steam not of course of equal density, but by which they got two-thirds of the work done, and at one-fourth of the cost. The next improvement had been made in the paddle; not so much, perhaps, in the wheel itself; for he was still inclined in favour of the old paddle-wheel, although for short voyages he admitted the advantage of the feathering paddle-wheel which had been advocated by Mr. Price at their meeting some years ago, and he had then opposed him; bnt of this hy-and-by. Another great improvement which had been made was the driving of the paddle-wheels faster. They had an old maxim which was, whereas a good old horse going 2½ miles an hour could not draw advantageously at more than 220 feet per minute, and that as the steam-engine was only a substitute for horses, and reckoned as so much horse-power, it ought not to go faster than 2½ miles per hour; and this one thing had kept them back for half a century. He did not mean that the result should be faster than 2½ miles per hour, hnt that the piston should not rise up and down in the cylinder faster than 2½ miles an hour, which was only 4 feet in a second, while the motion of steam of 15 lbs. was 1100 feet in a second. Fortunately, however, this old maxim had been abandoned, and the piston now moved from 250, 270, to 300 feet in a minute. For this improvement they were indebted to no new principle, but to the application of mathematical principles of science. He now came to another great improvement, which was the change in the formation of steam-boats, which had been radical—he meant the entire alteration in the form of the ships. A few years ago steam-vessels which would go ten or twelve miles an hour were deemed fast ships; now, however, we had attained a much higher rate of speed. Vessels were then built on the old-fashioned principle, that the water-line should be nearly straight, and that the run of the vessel should be a fine line, and that there should never he a hollow line, except a little in the run of the ship, hut that there most certainly should not be any hollow line in the bow, for there the water-lines should he straight or a little convex. Researches and inquiries were, however, made by a committee of the British Association as to the form which would enable the vessel to go fastest through the water. These inquiries lasted for years, and they established, by a series of experiments, a set of very curious facts. Formerly, every builder of ships had his notion of proportion; some that the length should be four times the breadth—others that it should be 4½ or 5—and some went as far as to say that the length should he six times the breadth, but these were deemed innovations: so that although the proportions of width as compared with breadth were said to be fixed ones, yet strangely enough every one differed as to those proportions. Another question was, what part of the vessel should have the greatest width, and it was generally thought that the greatest width should he nearest the bow. Some daring persons had, however, put it back as far as the centre of the ship. This was, however, the exception, and not the rule. Then there was another great principle, which was, that the bow and the stern should exactly balance each other, that is, that the vessel should be equally balanced. But the new rules which the British Association had established were as follow:—They began by upsetting the old rule with respect to the proportions which the length should bear to the breadth, finding that the greater the speed required, the greater should be the length, and that the vessel should be built merely of the breadth necessary to enable the engines to he put in, and to stow the requisite cargo. Then the second great improvement made hy them was, that the greatest width of water-line, instead of being before the middle, should be abaft the middle of the vessel, and in fact ⅔ths from the stern, and ⅓ths from the bow. The next great improvement was that, instead of having the bow broad and bluff, or a cod's-head bow, for the purpose of rising over the wave, you might have hollow water lines, or what were called wave lines from their particular form, and with that form the vessel would he propelled with less power and greater velocity—and also, that instead of keeping to the old fine run abaft and cutting it away, you might with great advantage have a fuller line abaft, provided it was fine under the water. Thus by these improvements the form of the old vessel was pretty nearly reversed, to the great annoyance of the old school, and the steamers were given large and commodious cabins and after-holds, instead of having cabins so pinched in that you could hardly stand in them. Another heresy, introduced by the British Association, was that of the principle as to the balance of the stern and the bow upon which they now rested; but which was founded in a most singular error, for they left out something which was very material. They concluded that the wave acted equally on both ends of the vessel in striking it; but they did not take into consideration the impossibility of this when a vessel was moving, not having taken into calculation the velocity of the wave or of the vessel, and that from this circumstance the concussion from a wave striking the bow would be a most powerful one, while it could not he so with regard to the stern; because, if the velocity of the wave meeting it was 15 miles, the shock would he as of 30 miles, and therefore it became most plain that the bow would give the greatest resistance to the wave. He had examined all the fastest steamers which had accomplished 15 to 17 miles an hour—and in smooth water 18 miles an hour; and he would venture to state, that there was not one of them which accomplished from 15 to 17 miles an hour, which had not all these alterations in every particular, and that the wave form and wave principle were now adopted by all the great steam-ship builders, and that all the fast steam-boats had what was called the wave bow. Now, of the eight boats on the Holyhead and Dublin stations, if examined, it would be found that all of them were built on these principles, although in some of them there was still left a little of the old principle, some of the boats being made a little fuller and more straight; and if any one would look at one of these boats, it would he perceived that the moment they moved the very wave itself rebelled against them, and broke against their bows—and that, consequently, these were slower than any of the others. All of them, however, were vessels of the first class; and he gave the details of their construction—for which we have not space. All of them were examples of the value of the form and the principles which the British Association had advocated and introduced at a very early period in its history.—Mr. J. Taylor stated, that as Treasurer of the Association, he could bear witness to the value of the efforts of the Association in this direction; and he felt bound in justice to state, that the credit Mr. Russell had given to the Association was chiefly due to himself, as the individual who, with the late Sir J. Robinson, had conducted the investigations on this subject.

Mr. J. Price rose to say, that he agreed with Mr. Russell in all that he had adduced. There was, however, one mode of steam navigation—one mode of propulsion, to which he had not alluded; he meant the mode of propulsion by the screw propeller. He would therefore mention, that they had built a little vessel, called the Neath Abbey, which plied from Neath to Bristol, a distance of upwards of sixty miles, and which had only two 12-inch cylinders; in fact a mere toy—of course using high steam. Now, she could walk round the Beresford, which had two 40 horse-power engines: the working her upon the high-pressure steam principle necessarily increased the speed of the piston. With these engines they had stepped out of the old track. They had not adopted the American plan of a high-pressure engine and puffing off the steam, hut of a high-pressure engine without puffing off the steam, and without using a jet of cold water. He confessed that, when this plan was proposed by his younger coadjutors, he, as one of the old-fashioned, hesitated; but at length he consented. The Neath Abbey had a screw propeller with three blades, which were immersed under the water—her propeller being about 3½ feet in diameter. The vessel is built in the best form, allowing sufficient breadth for her

engines. The two 12-inch cylinders are placed diagonally, and slung up by wrought iron beams, and they lay hold of one crank pin like the hands of two men working at a grindstone; and thus they conducted their engines almost in a snuff-box. Then they employed their boiler in the manner described by Mr. Russell. Then they came to the condensation of the steam; which they did not allow to go puffing off, but let it pass back into the boiler condensed and in a distilled state—which accounted for their never having any mud or dirt in their boilers.

Mr. J. C. Dennis read a paper "On Improvements in the Reflecting Circle—more particularly in reference to an Instrument for the purpose of Measuring regular Distances of the Sun and Moon."—So great is the accuracy required in instruments of this kind, that it is necessary to distinguish to the 5,940th part of an inch. The smallest error of construction therefrom produces a serious error in the observation; and to render the construction more perfect, the following suggestion is made:—Instead of attaching the circle (technically called an arc) to the parts which support it, let the whole be cast in one piece, and then placed, polished, or divided to suit the purposes of modern astronomy.

[The letters below came to hand too late for their proper place.]

ON THE FORMATION OF COAL.

The theory of the formation of coal by a deposit of drifted vegetable material, appears to be surrounded with difficulties which deserve particular attention. In the first place, an almost instantaneous precipitation of the material, of uniform thickness, must have occurred; and, if we view the matter in the light of a flood of water uprooting forests and carrying the trees away to the sea, what peculiar state of the liquid would be necessary to allow a mass of vegetable matter, unmixed with other substances, to subside in sufficient quantity to form a coal-bed? And again, how are we to account for the total change in the so-called law, immediately above the mass forming the coal-bed, as the distinct layers over the coal, whether composed of sandstone or shale, appear to be thickly embedded with vegetable and fossil organism? The whole seems to indicate a promiscuous deposition throughout the various strata, the prints of smaller plants, and casts of larger trees, being distinctly seen to be disposed in every assumable position.

Your Newcastle correspondent, Mr. King, refers to a specimen in the museum there, in which a portion of the interior has become coal, and here he touches upon one of the difficulties of the case. Again, your Glasgow correspondent, G. R. B., says that coal is a crystallized mineral, and therefore it must have been originally in a state of liquefaction. If this holds good, then we may in some measure account for the very rare occurrence of trees actually becoming coal; for in all my own observations in the carboniferous strata, the skin or bark only has been preserved as coal. But may not coal be a local, not a transported production? Suppose an area of material similar to a bed of peat-moss with an enshrined forest, to represent a coal-seam on the surface, and a subsidence of the strata to take place, so that a sea or lake would be substituted, answering as a reservoir for the deposition of the sand and driftings of floods, the drifted material, whether shale or sandstone, thus spread over the coal-bed, would form the superincumbent roof of the coal-seam, and this continuing for a series of years, until an expansion of the strata again developed the surface suitable for the growth of another coal-seam; thus the submergence and emergence going on continually, might be held to account for the various coal-beds and intermediate strata.

THOMAS ROBERTSON, M.E.

Fife Collieries, Sept. 25, 1848.

CONE PULLEYS—STEEL-YARD LEVERS—TEETH OF WHEELS.

Will any of your correspondents favour me with a simple method of finding the relative sizes of cone-pulleys, so that the original length of strap may answer for all the speeds; also, the readiest method of finding the proper lengths of levers and balance-weights, or steel-yard balls for large weighing machines.

I am told that there is a new method of finding the true shape of the teeth of wheels and pinions, which teeth have a bearing immediately that each enters the corresponding space. I understand it is found by a point on a disc of certain proportions, traversing a plane whilst rolled in contact with a curved template made to the pitch line of the other wheel or pinion. As the system is not in print, I should be glad to know the exact details.

LIGNARIUM.

Northampton, Sept. 2, 1848.

[We may afford some remarks on these subjects next month; meanwhile, we acquiesce in "Lignarium's" desire that they should be laid before our readers.—ED. P. M. J.]

MONTHLY NOTES.

PAYNE'S PATENT FOR PRESERVING WOOD, &C. AGAINST FIRE.—A series of experiments was exhibited recently on the shingles at low water, in front of Whitehall-wharf, Cannon-row, in the presence of Lord Auckland and several Lords of the Admiralty, the Speaker of the House of Commons, and many scientific gentlemen, to test the efficiency of the invention of Messrs. Payne to prepare wood in such a manner as to render it capable of withstanding the force of fire, and perfectly uninflammable, though exposed to the heat of flames, or burning masses of wood or coal. The experiments were as favourable as could be wished for. Three cottages of miniature buildings were ignited, two of them constructed of the wood prepared by the patentees of the invention, the other of unprepared wood. The cottage built of unprepared wood was speedily consumed, whilst those of which the wood had been prepared by the invention, although partially charred from the terrific heat of the fire, never became absolutely on fire, and resisted the utmost effort of the flames. The expense of preparing timber under the patent of Messrs. Payne is small, and by it many trees hitherto considered as of little importance may be hardened and made into the most elegant pieces of furniture. The timber prepared against the "dry rot" is impregnated or imbued with sulphate of iron, decomposed by muriatic acid. That which is prepared against fire is prepared with sulphate of iron, and with alum decomposed by muriate of lime; and that which is prepared against worms is composed of sulphuret of barium, decomposed by sulphate of iron. This invention is very important in many respects. It renders all kinds of woods capable of resisting fire; it hardens them, and produces on them a beautiful surface.

CHOLERA.—Some curious observations have just been published by Dr. Parkin, showing, apparently, that a certain mixture of carbonic acid gas with the atmosphere has a protective influence against the poison of cholera. The facts adduced are striking, and the practical application they suggest may be easily made whenever the disease shall, unhappily, reach us. 1. It has been observed that, in the progress of cholera from India across the continent of Europe, a great many places, possessing mineral waters, have escaped the disease. Baku, on the borders of the Caspian Sea, had not a single case, though the malady prevailed all around. Baden also escaped; and so, says the author, did all the towns in Germany celebrated for mineral springs containing a large quantity of carbonic acid gas. In England, the principal watering-places escaped the ravages of cholera. This was remarkably the case at Cheltenham, where not a single case occurred, although the disease prevailed extensively in the surrounding district. The Cheltenham waters abound in carbonic acid gas, which is constantly evolved and mixes with the atmosphere. The author quotes examples of other places possessing mineral springs, but wanting this particular gas, and these were visited by cholera. 2. It was noted that in Glasgow not one brewer's servant was attacked with cholera, while the other inhabitants suffered severely. In London, also, a similar exemption was also observed, although two of the principal breweries were situated in the very heart of the pestilence. This immunity the author ascribes to the constant liberation of carbonic acid gas in such manufactories; and partly perhaps to the effect of the same agent taken internally with the large quantities of porter drank by brewers' men. 3. In Paris, where the disease raged so extensively, the only neighbourhood that could be said to be exempt were the passages or arcades, which being lighted with gas have an unusual quantity of carbonic acid in their immediate atmosphere. 4. The author noted, while in Spain, that blacksmiths, and men engaged in any business, which, like the blacksmiths', required a charcoal fire constantly burning in their place of work, remained free from the disease. Here the charcoal was the source of carbonic acid. 5. It was observed, that while the Spanish infantry were severe sufferers from cholera, the cavalry almost entirely escaped. This immunity the author attributes to the fact, that Spanish cavalry are in the habit of sleeping in the stables, where a considerable quantity of carbonic acid gas is necessarily produced by the respiration of the animals. Lastly, the author mentions, that a town in the south of France was singularly exempt from cholera, while the surrounding district suffered severely. It appeared that the town in question contains several large breweries and a number of manufactories, constantly burning large quantities of charcoal; so that from these two sources a considerable supply of carbonic acid was disengaged into the atmosphere. From these several observations, the author concludes, with a strong show of probability, that carbonic acid gas has the power of neutralizing or destroying the miasma of cholera.

REPORT OF MR. TREMENHEERE ON THE STATE OF THE COAL AND IRON MINING DISTRICTS.—LANARKSHIRE:—Here, the commissioner states, he found no disposition to disregard the provisions of the Act, but that where 75,000 people are congregated within an area of a few miles round the iron-works, it is desirable to make frequent inspections and reports. An efficient body of rural police has been formed at the expense of the mining interest of the county, and, being distributed through the different mining villages, have contributed greatly to the cause of good. A sheriff-substitute and procurator-fiscal have been appointed, and the administration of justice brought home to the inhabitants. A water company has procured an act of parliament, and is about to supply a want which has been greatly felt; many schools have been established, and great attention is paid by the proprietors to decency and cleanliness in the rows of cottages belonging to them; at all the works one or two men are employed, whose sole duty is to keep the roads and spaces around the cottages clean, and report cases of wilful neglect; incorrigibly dirty families are dismissed; the greatest comforts are, however, everywhere visible. In this county the misguided men cannot be made aware of the follies and miseries attending a strike; notwithstanding the complete failure, as usual, of the one in the autumn of 1847, threats have been since held out of another; 20,000 to 30,000 join in them, and do an immense deal of injury, not only to themselves, but to the capital of their employers, and numerous industrious classes of the community,

and without the least chance of redressing what they term their own grievances. The most serious result of these strikes is the introduction of large numbers of Irish, who are induced to come into the vacant employ: of the miners, it is said, upwards of two-thirds are Irish, and of the colliers one-fourth, while every successive strike adds to their number; a better feeling, is, however, become perceptible. Some of the better class of workmen have detached themselves from the union, and sought work where their skill and industry could obtain their proper reward—steady and hard-working men earn generally from 1s. to 1s. 6d. per day more than those who belong to the union.—AYRSHIRE:—This county is now growing into an important mining district, and there appears to be a strong desire to prevent such a state of society arising as was exhibited a few years ago aronnd Airdrie and Coatbridge, in Lanarkshire. At the most important works (the Portland Malleable Iron-works) every precaution is being taken to secure health, cleanliness, and comfort; the cottages are detached, with upper story, back kitchen, front and back garden, and a very moderate rent charged. A miners' library of 260 volumes has been established, the charge being 1s. entrance, and 6d. per quarter; several daily papers and periodicals are taken in, and the reading-room is much frequented by colliers and miners. From 2000 to 3000 men will be employed when the works are completed. To the Glengarnock Iron-works (Messrs. Merry and Cunningham's), employing 2000 people, the same remarks will apply. As a whole, the report, which is dated August, 1848, is highly satisfactory, and evidences that a very improved condition in the habits, manners, and morals of the colliery population is rapidly advancing.

THE GREAT VIADUCT ACROSS THE DEE, IN THE VALE OF LLANGOLLEN.—While the speed to be attained by mechanical ingenuity is being intensely considered, the architecture of our railways is not forgotten, and we feel pleased to have it in our power to notice one of the most daring and stupendous efforts of skill and art to which the railway has given rise. We refer to the great viaduct now in course of completion across the valley of the Dee, in the Vale of Llangollen—the dimensions of which surpass anything of the kind in the world. While the tubular bridges across the Menai Straits and Conway River are, from their novelty, attracting much attention, the undertaking referred to has proceeded nearly to completion, without any considerable notice being taken of it. Its vastness of proportions may be better conceived, when it is stated that in magnitude it far exceeds what is considered the greatest effort of human skill in connection with railway communication —the Stockport viaduct. The Dee viaduct (for this is the term given to the one at Llangollen) is upwards of 150 feet above the level of the river—being 30 feet higher than the Stockport viaduct, and 34 feet higher than Menai Bridge. It is supported by 19 arches of 90 feet span, and its length is upwards of 1530 feet, or nearly one-third of a mile. The outline of the structure is, perhaps, one of the handsomest that could have been conceived, both as regards its chaste style and attractive finish, and its general appearance is considerably enhanced by the roundness of the arches, which are enriched by massive quoins, and the curvilinear batter of the piers: this style of architecture imparts a grace and beauty to the structure without impairing its strength. The greatest attention seems to have been paid to the abutments—the only part of the erection, in reality, where any decorative display could be made. In the middle of both, on each side, there are beautifully executed niches in the Corinthian order, in addition to some highly-finished masonry. The piers are neatly wrought at the angles, and at the base of each there is a bedding of upwards of 460 square feet of masonry. With the exception of the intrados of the arches, which are composed of a blue sort of brick, the whole structure is built of beautiful stone—if not as durable, equal in richness and brilliance to Darlydale. The viaduct has an inclination from end to end of 10 feet, and connects that part of the Shrewsbury and Chester Railway between Rhos-y-Medre and Chirk. Viewed from beneath, the vast structure presents a noble and truly grand appearance, and its bold proportions, with its height, cannot fail to call forth admiration from the most indifferent beholder. While the view below developes what art can accomplish, that from the summit surpasses in richness and luxuriance of the picturesque any landscape in the kingdom. Situated in the middle of the far-famed Vale of Llangollen, there is all that nature and art can bestow to make the view charming and beautiful. On one side are bold and swelling hills, on the other a plain teeming with luxuriance far and wide. Within view are Castell Dinas Bran, or, as it is commonly called, "Crow Castle," which is situate on the crown of a conical hill—the glaciated rocks, Wynnstay, and Pont-y-Cyssyllte, or the Dee Aqueduct. This last structure, which conveys the Ellesmere Canal, is within a short distance from the viaduct, and, from its beauty and extent, imparts additional interest to the locality. The viaduct has been erected by Messrs. Makin, Mackenzie, and Brassy, contractors, at a cost of upwards of £100,000, being upwards of £30,000 more than the Stockport viaduct. The cost of the timber required to form scaffolding, &c., for its erection was £15,000, and between 300 and 400 masons alone were employed during the whole time of construction. It is worthy of remark, that, up to Saturday last, no accident of consequence occurred to any of the persons employed in erection; but on that day, we regret to say, one of the workmen was killed on the spot by a portion of the scaffolding falling upon him. Within a few miles distance there is another viaduct in course of building across the valley of Ceiriog. This structure will be upwards of 120 feet high. and will have 10 arches of 45 feet span, and one of 120 feet. The entire length will be at least 850 feet, and will have cost, when completed, a large sum of money.—*Liverpool Mercury.*

EXPERIMENTAL TRIAL OF GIRDERS FOR BRIDGES.—One of those practical tests which has been of such advantage in the designing of the Conway tubular bridge, was recently made at Messrs. Fox, Henderson, & Co.'s works, Birmingham, under the superintendence of Mr. Locke. The subject of trial was a wrought-iron girder on the bowstring principle, which is now being applied on the extension line of the Blackwall Railway. The girder in question was constructed for a clear span of 120 feet; it consists of an arch of boiler-plates and angle iron, tied across at the ends with horizontal bars. The tie-bars are connected with the arch by vertical standards, and by a duplex system of diagonals, so arranged as to distribute the load equally over the whole arch, the versed sine of which was 8 feet 8 inches. The proof weight was fixed at 240 tons, gradually applied, and commencing with 34¼ tons. The following were the results of the different weights:—

Weight applied.	Extreme deflection at centre of arch.
34¼ tons,	1/16 inches.
68½ "	5/8 "
102¾ "	1 5/16 "
137 "	2 1/8 "
171¼ "	2 3/4 "
205½ "	3 5/16 "
240 "	3 11/16 "

The weight of a heavy goods train is calculated at half a ton per lineal foot; and the heaviest of all trains, namely, one of locomotive-engines, would weigh no more than one ton per lineal foot; therefore, the proving strain was more than double the amount that it can ever be tried with in practice.—The arched rib is of the section of a hollow rectangular trunk of boiler-plates riveted together with angle iron. The horizontal tie-bars, which act like the string of a bow in bolding together the extremities of the arch, are 8 inches by 1 inch. Expansion and contraction by changes of temperature, or by the action of heavy loads, are provided for by sliding shoes and cast-iron supporting rollers. The plan appears to offer great advantages in the way of security, and the obtaining a clear way beneath the arch.

MODEL LODGING-HOUSES.—One of the latest of the labours of the Society for Improving the Condition of the Labouring Classes, has been the opening of a lodging-house, in Old Compton Street, Soho, London, for clerks and the higher grade of mechanics. The building contains 136 sleeping-rooms, divided into two classes, the rent per week being 3s. 6d. and 2s. 6d. respectively. Every convenience is provided, in the way of separate coffee-rooms, baths, and lavatories; and a library and reading-room, supplied with daily newspapers and books, are also provided.

PREVENTION OF SMOKE.—Mr. C. W. Williams, the indefatigable smoke consumer, read a paper at the last monthly meeting of the Liverpool Polytechnic Society, on the smoke nuisance, and the means to be adopted in reducing it. He stated that the town council, well knowing the possibility of abating the evil, had issued 969 notices to parties who infringed the act referring to smoke; 220 informations were lodged for nuisances, and of these, 45 summonses were issued, 33 of these again being fined. He illustrated his views of the nature of combustion by diagrams, consisting of thin circular plates, of different colours and sizes, representing the combining proportions of oxygen, hydrogen, carbon, &c., as an atom, a cubic inch, or a pint. Take a quart, for instance, of hydrogen and a pint of oxygen, mix and raise them to the proper temperature, and they form water—this is combustion; or take one atom of carbon and two of oxygen, raise the temperature to a red-heat, and what is the result?—carbonic acid. The main conditions of combustion of gas were:—1. The quantity of air required. 2. The necessity for mixing it with the air. 3. The required temperature to secure perfect combustion. These are the conditions which must be attended to in the formation of, and conducting the operations in, the furnace, to secure the result desired—the absence of smoke. In the process of combustion of coal, few would imagine the immense mass of water which escapes up the chimney, in the form of high-pressure steam; for every single ton of coals consumed, nearly half a ton weight of water was formed, as every pound weight of hydrogen from the coal took up 8 lbs. of oxygen from the atmospheric air; and this, in a ton of average coal, gave 960 lbs. of water. It was essential in the construction of a furnace to provide for the escape of this immense mass of water in its highest state of expansion, in addition to a large proportion of carbonic acid and nitrogen. He then alluded to the unscientific mode of making the flame impinge on the boiler, to obtain the greatest heat, when, in fact, it cooled the flame, and made smoke. This he clearly proved by holding a piece of wire-gauze over a clear gas-jet, when a volume of dense smoke arose, from the cooling of the flame by the heat-conducting properties of the metal. He further illustrated the scientific correctness of his principle by numerous diagrams, and explained an ingenious gas-burner, peculiarly adapted for improving the light, by administering a full dose of oxygen to the flame, precisely on his principle of supplying it to the furnace.—The consumption of fuel in the Dublin Steam-Boat Company's last new ship, the Trafalgar, was 38 cwts. of coal per hour, when handed over by her builders; but, under the process of admission of air to the gases, this was reduced to 25 cwts., the engines being 350 horse power.

MANAGEMENT OF GAS.—Dr. Arnott has made some further remarks upon the use and management of gas, in reference to the late explosion in Albany Street, London. He gives some valuable practical instructions as to proceedings in cases of danger:—1. To have the apparatus made and fixed by competent workmen. 2. If any leak be perceived by the smell to have it promptly attended to, and to open doors or windows to prevent accumulation. 3. On no account to carry a lighted candle to where there is a strong smell of gas. 4. To have the room or rooms in which gas is burnt ventillated from near the ceiling. The balanced chimney valve which I proposed some years ago as a means of maintaining a healthy state of inhabited rooms generally, and which, having been mentioned in a clause added to the Metropolitan Building Act expressly to direct the mode of fixing it, is already extensively used, would, I believe, make it almost impossible for a dangerous accumulation to take place, even if the burner cocks were purposely left open; and wherever gas is used in an inhabited place, this valve is not more important as a security against explosion than it is to guard inmates against the deleterious effect of breathing the burnt air of common gas illumination or of any other. There is no patent right for the valve, and an adroit workman anywhere may make it. With these precautions, gas is, in a majority of cases, the most beautiful, convenient, and cheap means of lighting, and may be regarded as one of the precious boons of science.

ENGLISH PATENTS.

Sealed from 21st August, 1848, to 16th September, 1848.

Thomas Richardson, Newcastle-upon-Tyne, chemist,—"Improvements in the condensation of metallic fumes, and in the manufacture of white lead."—August 21st.

William Young, Queen-street, Cheapside, lamp manufacturer,—"Improvements in closing spirit and other cans or vessels."—21st.

Isaac Taylor, Stamford Rivers, Essex, gentleman,—"Improvements in preparing and engraving surfaces; also in the construction of cylinders adapted for engraving, and also in machinery for printing and ornamenting surfaces."—21st.

Richard Shaw, Gold's-green, West Bromwich, Staffordshire, railway-bar finisher,—"Improvements in the manufacture of iron into tyre bars, round bars, square bars, and flat bars, Tee iron, angle iron, and trough iron."—21st.

John Bethell, Parliament-street, Westminster, gentleman,—"Improvements in preserving animal and vegetable substances, and also stone, chalk, and plaster from decay."—21st.

Alexander Angus Croll, Gas-work, Tottenham,—"Improvements in the manufacture of gas, and in apparatus to be used in transmitting gas."—22d.

Hugh Lee Pattison, Washington-house, Gateshead, Durham, chemical manufacturer,—"Improvements in manufacturing a certain compound or certain compounds of lead, and the application of this and certain other compounds of lead to various useful purposes."—22d.

Alonzo Buonaparte Woodcock, Manchester,—"Improvements in steam-engines, and in apparatus for raising, forcing, and conveying water and other fluids."—22d.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—"Certain improvements in dressing or cleaning grain, and in separating extraneous matters therefrom."—(Communication.)—22d.

Edward Dench, Hursterpoint, Sussex, hot-house builder,—"Improvements in the roofing of conservatories, hot-houses, and other like structures."—26.

William Young, plumber, and Henry Burgess Young, engineer, Barnstaple, Devon,—"Improvements in smelting and refining lead ores."—28th.

Charles Rowley, Birmingham, button manufacturer,—"Improvements in the manufacture of buttons."—28th.

Elizabeth Chrees, Homerton Castle, Homerton, Middlesex,—"Improvements in the manufacture of sealing wax."—29th.

Peter Wright, Dudley, Worcestershire, vice and anvil manufacturer,—"Certain improvements in the manufacture of vice boxes, and in the machinery for effecting the same."—31st.

George Nasmyth, Ebury-street, Pimlico, Middlesex, civil engineer,—"Certain improvements in the construction of fire-proof flooring and roofing, which improvements are also applicable to the construction of viaducts, aqueducts, and culverts."—September 4th.

William Wheldon, engineer to Messrs. John Warner and Sons, Jewin-crescent, London, brass-founders and engineers,—"Improvements in pumps or machinery for raising or forcing fluids."—4th.

John Lewis Ricardo, Lowndes-square, Middlesex, Esq., M.P.,—"Improvements in electric telegraphs, and in apparatus connected therewith."—4th.

William Edward Hollands, 73 Regent's Quadrant, Middlesex, dentist, and Nicholas Whitaker Greene, 15 Walton-place, Chelsea, gentleman,—"A new manufacture of artificial fuel in blocks or lumps."—4th.

William Losh, Newcastle-upon-Tyne,—"Improvements in steam-engines."—4th.

Henry Smith, Vulcan Works, West Bromwich,—"Improvements in the manufacture of railway wheels."—5th.

William Dickinson, Blackburn, Lancashire, machine-maker,—"Certain improvements in, and applicable to, looms for weaving."—11th.

SCOTCH PATENTS.

Sealed from 22d August, 1848, to 20th September, 1848.

Alexander Turiff, Hamilton-street, Paisley, Renfrewshire, engineer,—"Certain improvements in railway turn-tables."—August 23d.

Richard Shaw, Gold's Green, West Bromwich, Staffordshire, railway-bar finisher,—"Improvements in the manufacture of iron into tyre bars, round bars, square bars, and flat bars, Tee iron, angle iron, and trough iron."—23d.

Isaac Taylor, Stamford Rivers, Essex, gentleman,—"Improvements in preparing and engraving surfaces; also in the construction of cylinders adapted for engraving, and also in machinery for printing and ornamenting surfaces."—28th.

George Walter Pratt, Rochester, State of New York, U. S., gentleman,—"Improvements in the manufacture of printing ink."—30th.

Elizabeth Dakin, No. 1 St. Paul's Churchyard, widow, as administratrix of the late William Dakin,—"Improvements in cleaning and roasting coffee in the apparatus and machinery to be used therein, and also in the apparatus for making infusions and decoctions of coffee"—31st.

William Dunt, Dodderhill, Worcestershire, chemist,—"Improvements in obtaining certain metals from certain compounds containing these metals, and in obtaining other products, by the use of certain compounds containing metal."—September 5th.

Richard Madigau, Haverstock Hill, Hampstead Road, Middlesex, civil engineer, and John Coope Haddan, 14 Lincoln's-Inn-Fields, Middlesex, civil engineer,—"Improvements in the manufacture of wheels for railways."—5th.

Joseph Lillie, Manchester, Lancashire, engineer,—"Certain machinery or apparatus, applicable for purifying and cooling liquids, and for purifying condensing and cooling gases."—7th.

Thomas Dunn, Windsor Bridge Iron Works, Pendleton, near Manchester, Lancashire, engineer,—"Improvements in the manufacture of railway wheels and axles, and in machinery and apparatus for placing carriages on to a line of rails, for removing them from one line of rails to another, and for turning them."—7th.

William Swain, Pembridge, Herefordshire, brickmaker,—"Certain improvements in kilns for burning bricks, tiles, and other earthen substances."—7th.

William Edward Hollands, Regent's Quadrant, Middlesex, dentist, and Nicholas Whitaker Greene, Walton-place, Chelsea, Middlesex, gentleman,—"A new manufacture of artificial fuel in blocks or lumps."—7th.

Mary Campbell, Longforgan, Perthshire, widow,—"Certain improvements in the driving machinery of thrashing, grinding, and other mills."—(Communication from her late husband, Alexander Campbell, before his decease.)—8th.

Alexander Arnot, Lenton Works, Nottinghamshire, bleacher,—"Improvements in apparatus connected with the working of steam boilers, also in spring apparatus in balances, and in the means of working breaks."—11th.

IRISH PATENTS.

Sealed from 20th August, 1848, to 20th September, 1848.

William John Normanville, Park Village, Middlesex, gentleman,—"Certain improvements in railway or other carriages, partly consisting of new modes of constructing the axle boxes and journals of wheels; also an improved method of lubricating the said journals, or other portions of machinery, by the introduction of aqueous alkaline, oleaginous, or saponaceous solutions."—August 26th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 17th August, 1848, to 14th September, 1848.

Aug. 17th,	No. 1540.	Abraham Bettridge and Co., Birmingham,—"Penholder."
—	1541.	Richard Burrows, Ruddington, Notts,—"Regulating apparatus, or stop-guage, for farming implements."
—	1542.	Lynch and Inglis, Manchester,—"Pressure guage."
18th,	1543.	William Day, King William-street,—"Beer tap."
21st,	1544.	Robert Weare, Birkenhead,—"Galvanic diffuser."
22d,	1545.	Shaw Thewlis and Peter Griffith, Warrington,—"Cheese press."
—	1546.	James Camphell, Beak-street, Regent-street,—"Champagne and aërated water-fountain tap.
—	1547.	Thomas Spicer Dismore and George Dismore, Clerkenwell-green,—"Waistband centre."
23d,	1548.	William Armitage, Louth,—"Safety signal light."
24th,	1549.	Samuel Messenger, Birmingham,—"Railway signal lamp."
25th,	1550.	Isaac Rider, Bedminster, Bristol,—"Bib-cock."
26th,	1551.	Alexander Lewis, Fenchurch-street,—"Protective machine for cleansing, painting, and glazing sashes."
—	1552.	Messrs. Wilson, Wardour-street, Soho,—"Artists' sketch box."
—	1553.	Arthur Perks Dudley, Birmingham,—"Trouser strap."
28th,	1554.	I. and W. A. Blair, Trongate, Glasgow,—"Compass hats."
—	1555.	William English and Son, Brighton and Lewes, Cutlers and Surgical Instrument Makers,—"Dr. Madden's uterine douche bath."
29th,	1556.	John Crutchley de Witte, 43 Threadneedle-street,—"Penbolder."
—	1557.	Hilliard and Thomason, Birmingham,—"Fastenings for articles of dress."
30th,	1558.	J. Tylor and Son, Warwick-lane,—"Flush lap joints for metal grooves."
—	1559.	Henry Walker, Gresham-street, London,—"Penelope crochet needle."
—	1560.	William Norris, Gloucester-place, Hackney,—"Wood frame soap-cooler."
Sept. 1st,	1561.	Frederick Chas. Rein, Strand,—"The lavatuha, or breast reliever."
—	1562.	Winfield and Simms, New Bond-street,—"Music stand or easal."
2d,	1563.	James Gilbert, Craven-buildings, Drury-lane, and Charles and William Lancaster, New Bond-street,—"Embossing press."
4th,	1564.	Joseph Guise, Margaret-street, Wilmington-square,—"Gas burner and apparatus."
—	1565.	Joseph Hor. Cutler, Birmingham,—"An eye (hook and eye)."
—	1566.	Deane, Dray, and Deane, King William-street,—"Stove."
—	1567.	Lane and Barkentine, Upper Seymour-street, Euston-square,—"Safety buckle."
5th,	1568.	Charles and William Lancaster, New Bond-street,—"Tumbler for a gun lock."
—	1569.	Robert Walter Winfield, Birmingham,—"Letter balance."
—	1570.	James Kimberley, Birmingham,—"Cramp."
—	1571.	François Perroncel and D. G. Wertheimber, West-street, Finsbury,—"Artificial leach."
6th,	1572.	William Frederick White, Brinton, Norfolk, farmer,—"Stack protector."
—	1573.	Hubert and Vargus, Margaret-street, Cavendish-square,—"Rivet button."
7th,	1574.	John Calleott, Roehampton-street, Vauxhall Bridge-road,—"Rolling valve brass wind instrument."
—	1575.	William Crane Wilkins, Longacre,—"Pressure lamp."
9th,	1576.	Wm. Prockter Stanley, Peterborough, ironmonger,—"Rolling mill for crushing grain, seeds, and chemicals."
—	1577.	Jonathan Ashby, Greenwich, engineer,—"Screw friction clutch."
11th,	1578.	Wm. Campbell Sleigh, Brick-court, Temple,—"L'agraffe facile (clasp)."
—	1579.	Sandford and Owen, Phœnix Works, Rotherham,—"Portable apparatus for steaming food for cattle."
12th,	1580.	David Ilesse, Manchester,—"Combination neck-tie."
—	1581.	Brown and Jackson, Derby, engineers,—"A mill."
13th,	1582.	Griffiths and Hopkins, Birmingham,—"Nozzle for candlesticks."
—	1583.	Thomas Horton James, Bucklersbury,—"Chopping-knife."
—	1584.	Burgess and Cooper, Crosby-row, Walworth,—A pair of overalls."
14th,	1585.	Ferguson, Miller, and Co., Glasgow,—"Chimney-top."

TO READERS AND CORRESPONDENTS.

J. C. M. Bow.—We had the matter under consideration some time ago. His observation is a just one, but the arrangement has its disadvantages.

New York.—In the course of last month a New York pamphlet reached us through the post-office, with a charge of four shillings upon it. However strongly we may be inclined to exchange communications with America, or any other distant locality, we cannot afford it on these terms. The pamphlet was returned.

A. W., Edinburgh.—His traction rack has been often proposed. It is nothing more than a return to the old system in vogue previous to the establishment of the smooth wheel plan. Such an arrangement is not at all desirable, for although the slipping of the wheels is a very frequent annoyance, yet it may be remedied in a far simpler manner by applications of chalk or sand to the slipping surfaces.

M. Sproul.—Are we to understand that his letter is a new specimen of phonography? The last paragraph only, appears to concern us. We have not the houour to be the party to whom he refers.

T. Ford, London.—We shall be glad to assist him in any matter within our province. If he has three separate pumps, it is immaterial whether their pistons are worked by one or three rods—the labouring force will be the same. If one pump requires a pressure of 10 lbs., three will certainly require 30.

A. Walker, Cheltenham.—The engines and gearing have already been published in another work. This was previous to the alterations we have chronicled. It is doubtful, whether, in this particular case, the publication of the specifications would be of much value. Certainly, in many instances, these documents are of very great service; we will attend to his suggestion so far as to examine them. His other remarks will also be borne in mind; for his politeness, we owe our best thanks.

R. B. Bilston.—His favours will be duly acknowledged. A practical test will set it at rest.

F. S. Stott.—Any one may make the valves. There is no monopoly in the matter.

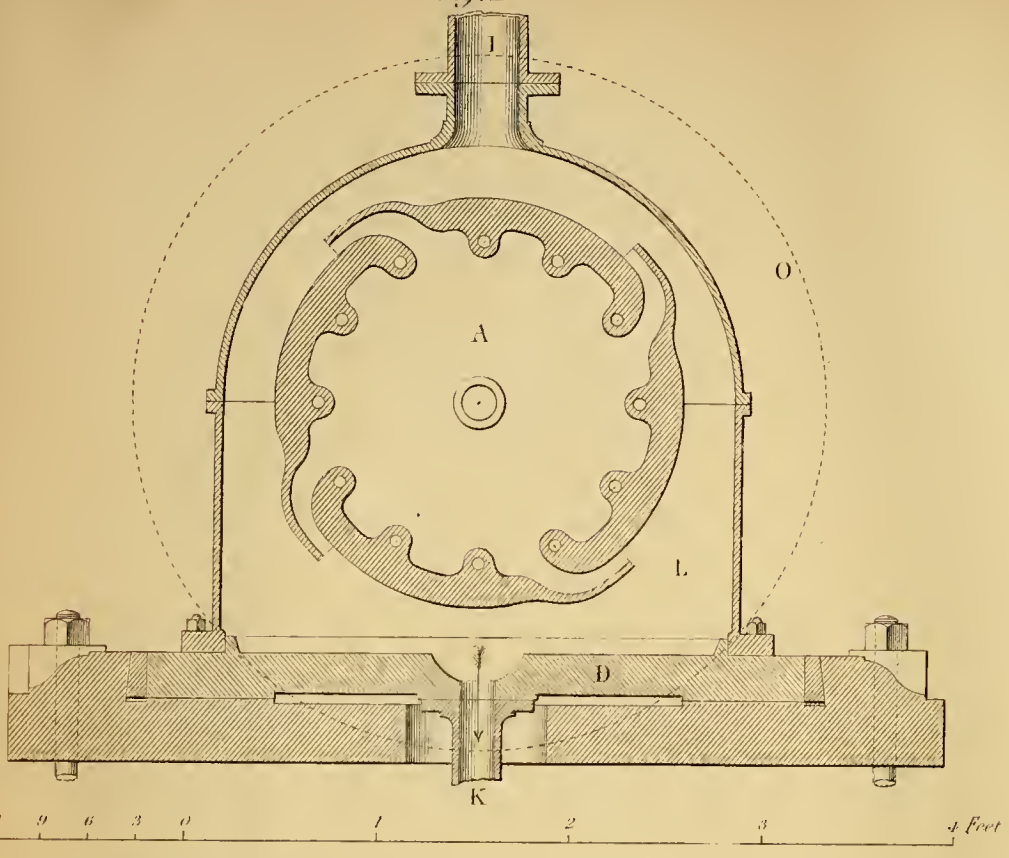
R. R., Belfast.—We were not present at the trial, nor did we subsequently see anything like the number of the machines mentioned. To have given a full detail would have encroached excessively upon our space.

J. Forman, Edinburgh.—To follow out the line of operations he mentions, would require the whole attention of many men for life. His observations are in many respects excellently intended; when any of them can be acted upon, they will receive our best attention.

STEAM SAW.

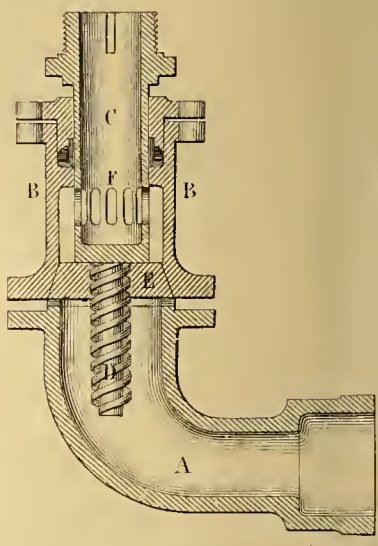
Transverse Section.

Fig. 1



SCOTT'S HYDRANT.

Fig. 3

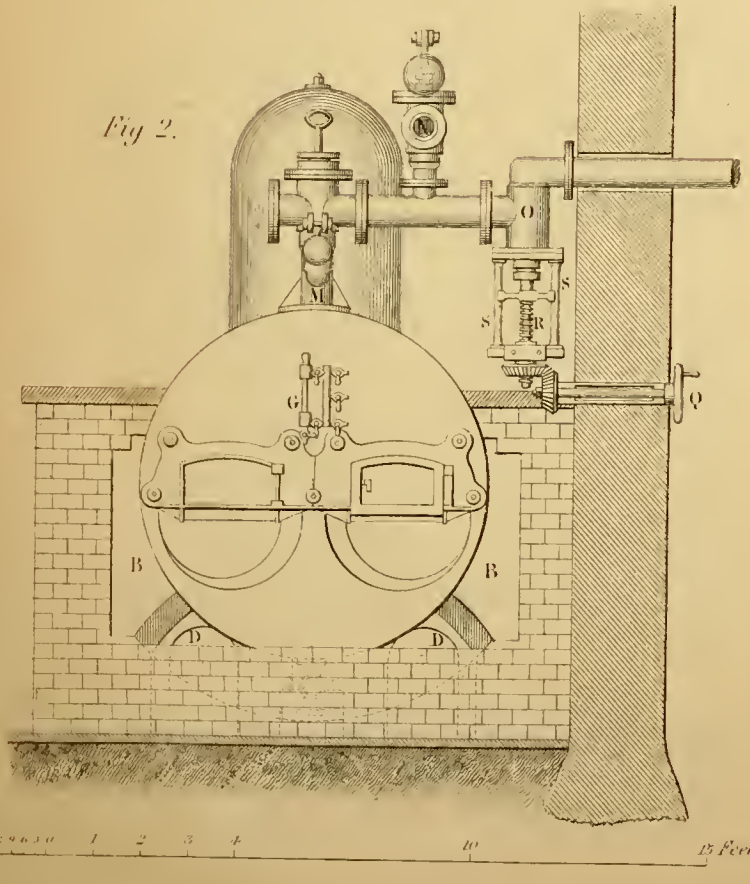


1/6th

HIGH PRESSURE BOILER.

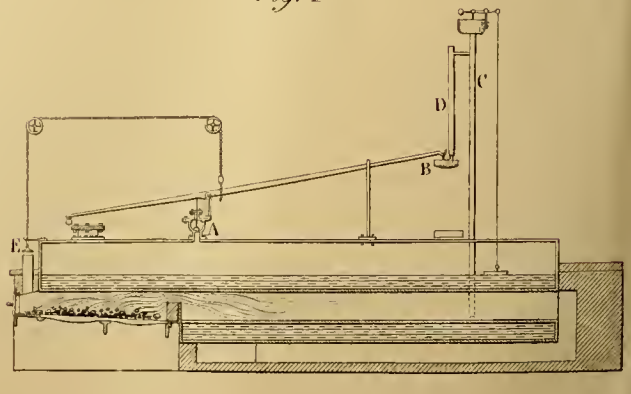
End Elevation.

Fig 2.



WALMSLEY'S SAFETY VALVE.

Fig. 4



W. Yates, 31, Patent Office, Lincoln's Inn.

Printed by Cunnington, Mucklow & Kirkwood, Lith.rs

Fig. 1.

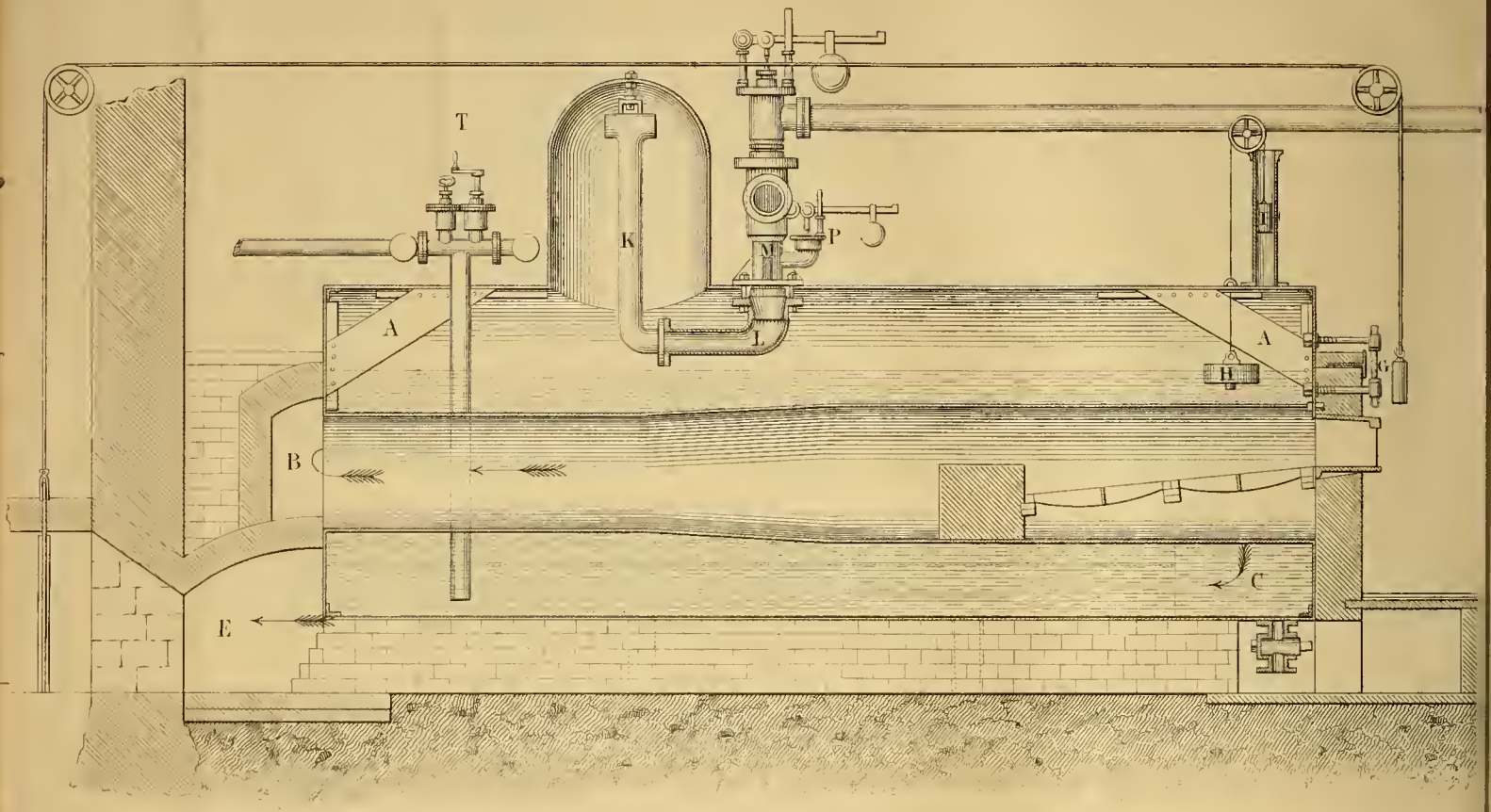
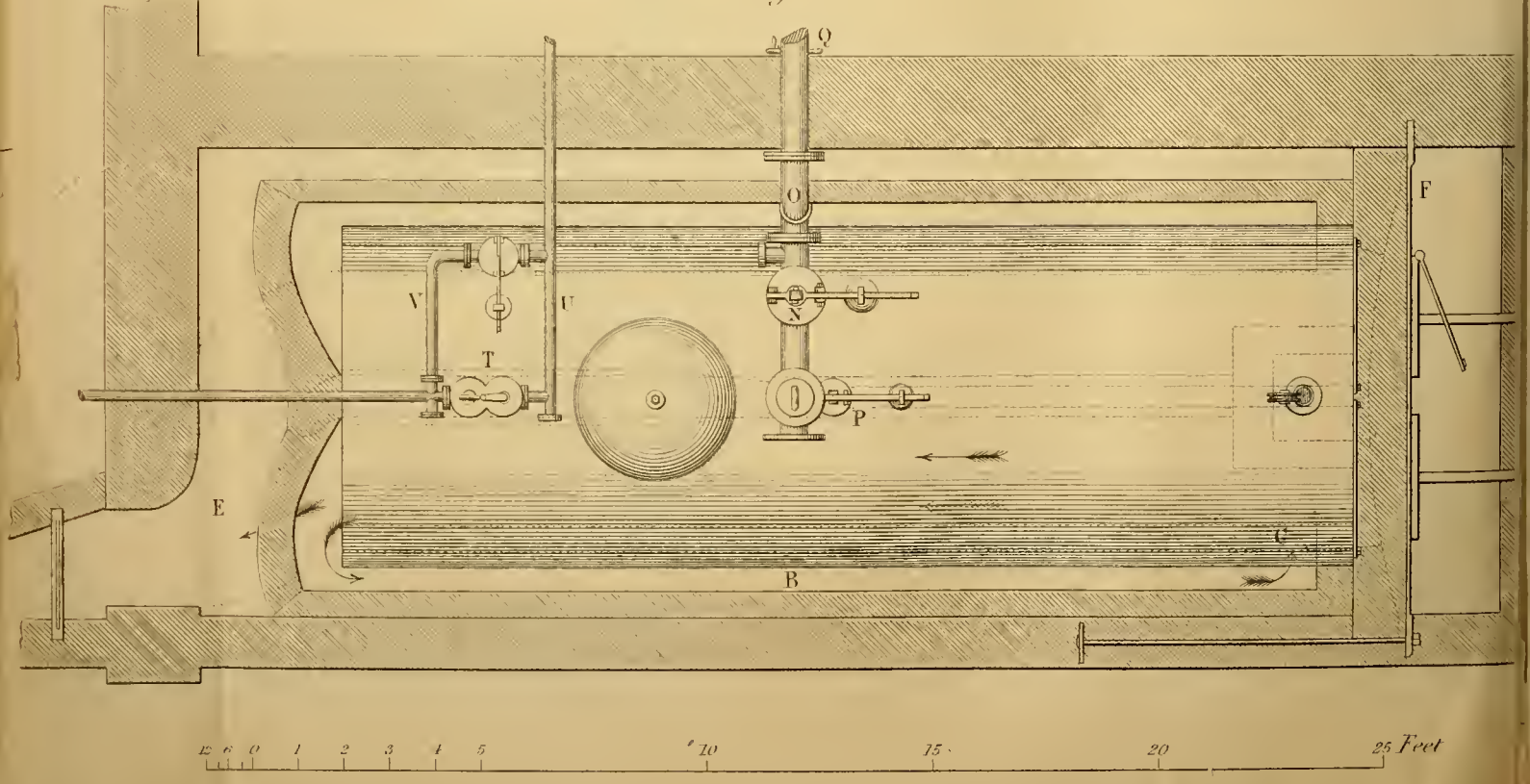


Fig. 2.



12 6 0 1 2 3 4 5 10 15 20 25 *Feet*

Printed by Maclure & Macdonald, Lithographers, Glasgow, Liverpool & London.

Fig. 1.

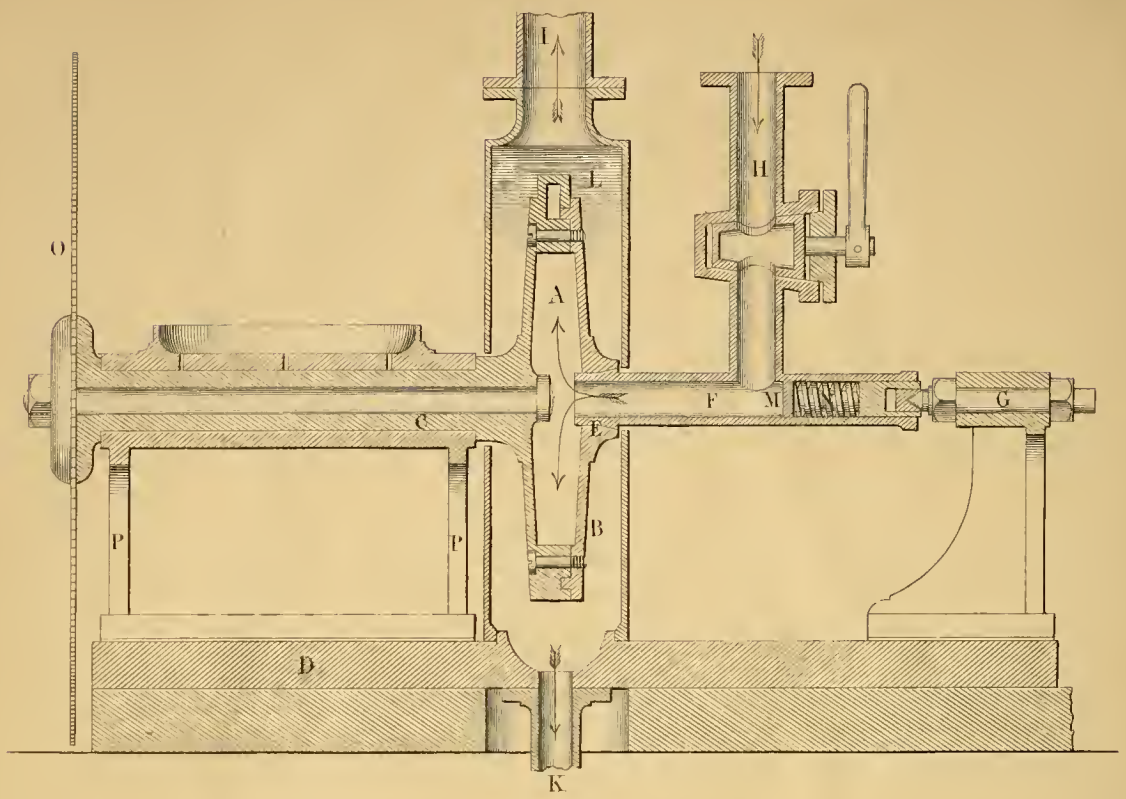
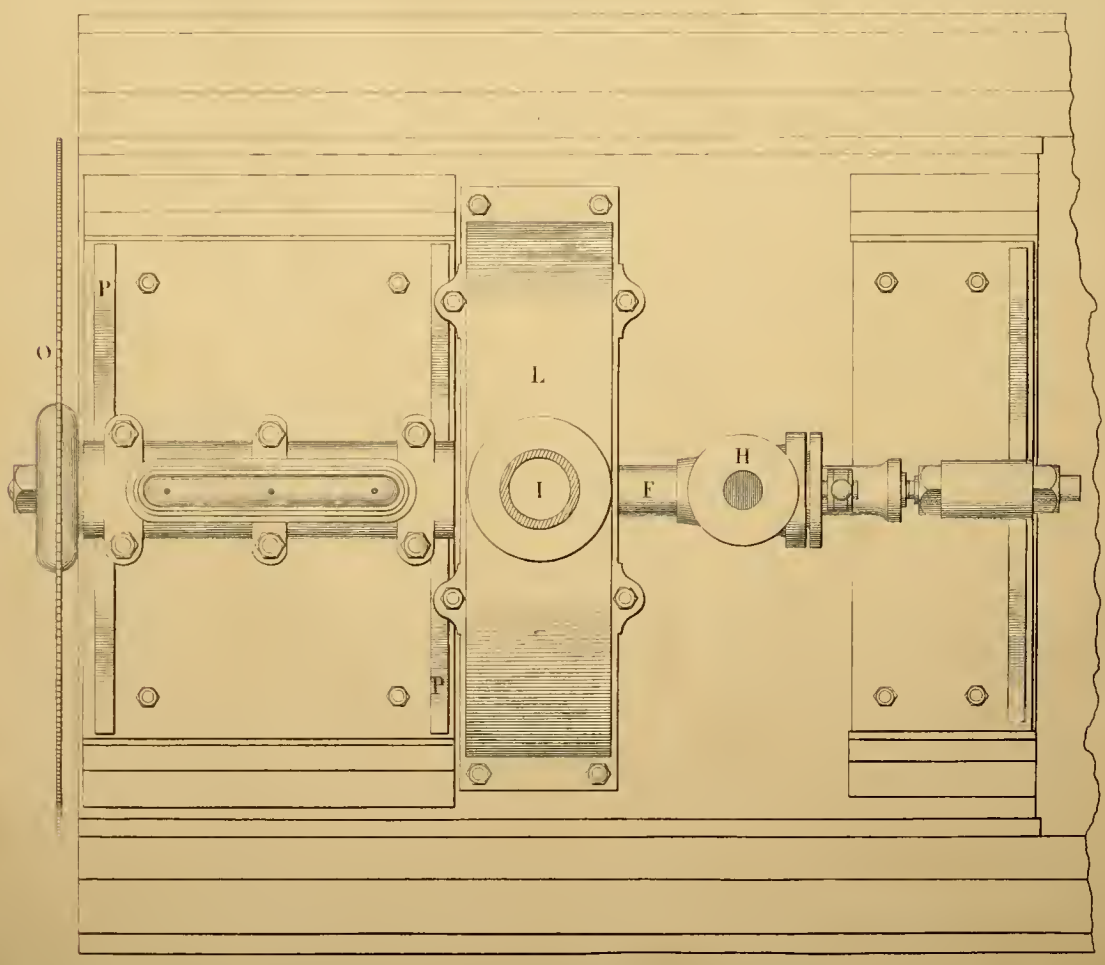


Fig. 2.



PRACTICAL NOTES.

THE MANUFACTURE OF COKE.

We have had repeated applications from our readers, for practical information on the subject of the manufacture of coke, and the general routine of the production of carbouized fuel. Inquiries on this head have accumnlated upon us to a considerable extent, and as separate and distinct replies would afford nothing more than a few isolated observations ou the varions processes pursued in different parts of the world, we have preferred to draw np a methodical chapter for the better explanation of the rationale of this most extensive branch of manufacture.

With the extension of railways, and of the multitudinous pursuits bronght into existence, and npheld mainly through the aid afforded by railway transit, the manufacture of coke has grown, out of a rude aud limited operation, to be a brauch of trade of the first magnitude, but not until a very late period have the refinements of philosophical principles added much to the crude details formerly adhered to by the rustic prodncer. Different branches of the arts have demanded, and brought forward, different methods of desnlphurization, and each new application has rendered necessary, novelties pcculiar to itself. Hence, all the primary varieties of fuel, as wood, tnrf, brown coal, and common coal, have found their own applications in the arts, under the names of charcoal, peat-charcoal, and coke.

The less oxygen contained in the fnel, the more numerous are the prodncts of decomposition which the predominant hydrogen forms with the carbon, as in coal. Of all fnels, that which has obtaiued the name of brown coal is the worst adapted for carbonizing, although, in facility of decomposition by heat, it stands on the same level as wood. This is a coal of the tertiary formation, exhibiting the most distinct marks of vegetable remains, in many cases so clearly, that the most minute portions of the leaves and fruit have been made out, and their botanical arrangement completed. It possesses the least uniformity of all coals, and sometimes occnrs entirely devoid of vegetable remains. In the more abundant secondary formation of mineral coal, or coal proper, we obtain the true raw material for the production of coke. The specific gravity of this coal varies from 1·2 to 1·4, and its ash is distinguished by containing no alkalies, but only alumina, silica, and oxide of iron. Dr. Richardson, of Newcastle, has accurately tested the specific gravity and the residual ash of almost every kind of coal. We give below, the results obtained from several British varieties:—

	Specific Gravity.	Ash per 100 parts.
Wylam Banks, Newcastle,	1·302	13·912
Glasgow Coal Field,	1·307	1·128
Wigan, Lancashire,	1·319	2·545
Edinburgh Parrot Coal,	1·318	14·566
Jarrow, Newcastle,	1·266	1·676
Chief Mass of Glasgow Coal,	1·286	1.421
Garesfield, Newcastle,	1·280	1·393
South Hetton, Dnrham,	1·274	1·519

The same observer has recently given a correct analysis of the component gases of these coals, which may be here introduced:—

	Carbon.	Hydrogen.	Oxygen Nitrogen.
Wylam Banks,	74·823	6·180	5·085
Glasgow,	82·924	6·491	10·457
Wigan,	83·753	5·660	8·039
Parrot,	67·597	5·405	12·432
Jarrow,	84·846	5·048	8·430
Glasgow Chief Mass,	81·208	5·452	11·923
Garesfield Deep Bank,	87·952	5·239	5·416
South Hetton,	83·274	5·171	3·036

The anthracitic, or trausitionary formation, is perfectly homogeneous, and presents no appearance of vegetable remains. It may be considered as a species of natural coke, as it consists almost entirely of carbon. Many kinds of coal pass, during the process of decomposition, into a species of fusion, and the gaseous bubbles arising, appear to be emitted from a pasty mass. The richest of all in carbon, is sand coal; but the theoretical richness in carbon is by no means a true test of the qualifications of coal as a coking material. In smelting furnaces, for instance, the coke must possess considerable solidity, to enable it to withstand the pressure of the materials without being crushed. Sand coal, and the too highly caking coal, are both objectionable in this point: the first produces a powdery coke, having a very feeble cohesive power; the second is too cellular, and for this reason the masses give way, and fall down under a very moderate pressure. Different opinions prevail as to the actual inferiority of these kinds of coal, but it is generally acknowledged that sinter coal, which combines some of the properties of both, is to be preferred to either. Our late experience has, however, shown that the relative hardness or softness of coke depends materially upon the method pursued in its conversion from the raw material, the different qualities of which must be carbonized on principles correctly suited to their primary compounds. Under the pressure of a heavy covering, the blisters formed by the escape of the gases are compressed together, and greater density results.

In the extensive manufactories lately called into action, vast ranges of furnaces have been erected for the more economical coking of fuel, but the older method of simple heaps is still in use in many districts. Originally, the heaps were nothing more than mere circular mounds of small diameter, but, in order to obtain a greater extent of preparing surface, long heaps have been introduced. The ground of the heaps is composed of the waste dust and pulverized matters resulting from former cokings, and upon this, as a floor, large masses of coal are leant against each other a long row over a guiding string, so as to form an ignition passage or archway. Over these a layer of smaller pieces is placed, with their natural lines of stratification upright, and their fractured surfaces at right angles to the longitudinal centre of the heap. This is continued in the same manner to the top of the heap, gradually diminishing the size of the pieces. Over this substratum the coking heap is then erected, with no other attention to arrangement than that of retaining the large masses near the bottom. Openings for lighting are ingeniously obtained, by driving stakes into the ground at distances of two feet asunder, previous to the erection, and upon drawing these out, apertures are left of size sufficient for the introduction of burning fuel, the draught for which is obtained by the central ignition passage in the bottom of the mass.

During the progress of the combustion, the burner watches the state of the external surface of the heap, and when the dense smoke ceases to issue from any point, or if an ash begins to form, he covers the place with powdered coke or charcoal dust, adding the coating gradually as external combustion appears, until the whole heap is completely covered, giving the windward side the thickest cover to secure it from the influence of the wind. In this simple but uneconomical method, the direction of the fire's action is from the exterior, where the light is introduced, downwards towards the centre to reach the channel for the conduction of the draught, so that the upper and outer layers of coal are actually coked, and are undergoing consumption as coke, before the main interior bulk has been reached.

The open air system is also carried on under another modification, whereby the carbonization proceeds outward, and the loss by external combustion is obviated. The plan which is in operation at the Clyde Iron Works, near this city, consists in the application of a central brick chimney, with a more philosophical arrangement of the coking mass, which is in the form of a circular mound. A conical chimney of brick, with a three feet base, is first erected on the floor of the mound, and

carried up to a height of three or four feet, a brick being left out at intervals in the course of its erection, forming apertures leading into the interior of the brick cone. Round this cone, as a nucleus, the coal is piled, placing the largest masses at the bottom, and leaving open channels for the communication of the atmosphere, with the openings in the central chimney.

The mound when completed is about twenty feet in diameter, and four feet six inches in height when covered with its external stratum of cinders. The fire is applied down the mouth of the chimney, the flames commencing at the bottom, and radiating outwards to all parts of the mound, and openings are made at the base for the free passage of air to the central flue.

In four or five days the surface is seen through the covering to be red hot, and all connection with the atmosphere is then cut off by placing an iron plate or damper on the top of the chimney, and closing up the side apertures for three days, when the coke is drawn.

In other quarters where the chimney is used, the process resembles that pursued in the heap system first described. The mound has no covering, and the chimney is covered over immediately after ignition. The coal of different districts requires distinct arrangements for coking; for instance, the large coal of Staffordshire may be conveniently and cheaply coked in the open air, but that of Newcastle, which is small, cannot be properly converted without an oven. In the latter locality, the usual time of conversion is 50 hours; but this depends materially on the state of the atmosphere, notwithstanding the process is conducted without any direct communication with the external air. Although 50 hours is deemed a sufficient period, it is to be remembered that a slower rate of conversion produces a far better quality of coke, brighter in colour, more sonorous, and in a more complete state of desulphurization. The heated bottom of the oven is first spread with a 10-inch layer of small coal, which ignites without further trouble, the oven never being allowed to cool when once in operation. So soon as the flame has covered the top of the coal, the door is gradually closed, and the process goes on without further attention. In about 40 hours, the evolution of smoke will have nearly ceased, and in 10 hours more the flame disappears, when the charge may be drawn; but if allowed to remain in for 40 hours longer, with the doors and chimney closed, the quality is highly improved. The drawing is effected by a large iron bar, by which the coked mass is broken, and the pieces are spread out to cool without the addition of water. Of the various kinds used for coke in the Newcastle district, that of the Tanfield Moor is considered to be the best; and as some proof of the superiority of the article, it may be stated that the Royal Copper Works at Mansfeld, in Prussia, use Newcastle coke. As an improvement upon the ordinary coke ovens, M. Michant has patented, in this country, a species of triplicate oven, or chamber, divided into three separate compartments, each fitted with its fire-place, furnace-door, and ash-pit. In his process, each of the compartments is charged with coal, and the fuel is ignited in the ordinary way, the furnace-doors being rendered air-tight by luting. It is by the radiation of heat from any one of the compartments to the other two, that economy is here aimed at; and for this purpose, in commencing to coke, the central compartment is first charged and put in action, and the heat radiated therefrom acts upon the uncharged divisions, the object being that the conversion shall be carried on in each compartment in regular succession. By the time the last compartment is charged, the first one is ready to draw, and when the latter is recharged, the second one is fit for drawing. Thus the process will be conducted without intermission; at the same time, that division which contains the cold charge will receive caloric from the side and crown of the adjoining one. We are told that the coke so prepared is of superior quality.

Next month we shall enter upon a survey of the more recent improvements in coking, illustrating the subject with engravings of the best furnaces now in operation.

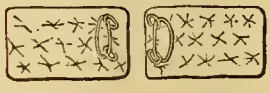
ON RENDERING SHIP FURNITURE AVAILABLE FOR THE PRESERVATION OF LIFE IN CASES OF SHIPWRECK.

The great objections to most of the schemes propounded for the preservation of life at sea, are their complexity, expense, and practical uncertainty of application when emergencies arise. The experimental tests of scientific apparatus, of which we often hear, are seldom productive of much good, for they merely explain the utter discrepancy which exists between the nicely-appointed arrangements of a set trial, and the scene of confusion and alarm consequent upon actual cases of danger. Some American ships lately set the example of securing safety in a simple manner, by forming air-tight cases in connection with the seats of chairs and stools; and lately a plan was laid before us, wherein buoyancy of the different articles of furniture is proposed to be obtained in a still more practically available way. To Dr. G. M. Scott of this city, we are indebted for the promulgation of the principle, which consists simply in fitting waterproof covers to the buoyant articles of furniture and fittings of the cabins.

The buoyancy of an ordinary pillow is amply sufficient to support a person in the water, provided it is preserved from saturation; and this, Dr. Scott proposes to accomplish by means of waterproof covers, to be fitted to all articles of the pillow class, as bolsters, mattresses, sofa cushions, and chair bottoms. Fig. 1 illustrates one of the modes in which two pillows may be rendered useful for the support of a single person. Each end of the pillow is provided with an attaching loop, so that the two may be slung together by stout straps, intended to act as shoulder straps. When in use, the head is passed between the two pillows, one of which will then be above the breast, and the other above the back of the shoulders, whilst the arms are thrust through the connecting straps to retain the whole in its place. Fig. 2 explains the mode in which a mattress may be applied to the same purpose. For the sake of a convenient support, it is divided into two parts, each of which has two loops and a shoulder strap. One of the halves is placed on each side of the body, and the arms are passed through the straps as before. A mattress may thus be made to afford an excellent support, but it is not so convenient as the pillows, for the reason that it confines the action of the arms. In some cases, the waterproof covering might be carried out between the two halves, in the shape of a suspended dress, to button round the neck, and afford a protection against the effects of the water.

Fig. 1.

Fig. 2.



The application of the different modifications would of course depend materially upon the nature of the accident, as affecting the time allowed for preparation. Mattresses might be rendered still more efficient, by fitting in a small compartment for containing some stimulant or a portion of highly-concentrated food. Amongst other suggestions, the seats and backs of chairs, if stuffed and waterproofed, could be easily attached to the body by straps. A hammock, with a waterproof outer covering, would answer to save a sailor and all his bedding; and a pair of paddles would afford the means of motion.

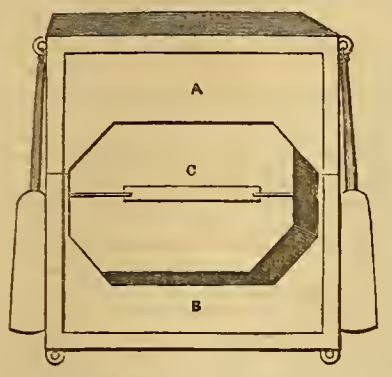
In such cases as those of the Pegasus and Monarch of the Ocean, where time would have permitted each person to avail himself of means of the kind, the adoption of the plan might have saved many lives. The first question in adopting anything new, is the expense; here it is nothing more than that of a suitable protective covering and a strap—a mere nothing in the fittings of a ship. We shall be glad to hear of Dr. Scott's humane proposition being put in operation, as it possesses two eminent qualifications—cheapness and simplicity.

As we were writing these remarks, we received a model and a voluminous series of drawings, bearing upon the same subject, from Mr. Francis Taylor of Leith. Mr. Taylor has for some years paid considerable attention to the devising of apparatus for saving parties from drowning, and the public is indebted to him for a number of useful suggestions for that purpose. His general views agree with those of Dr. Scott, as in the rendering the ordinary fittings of ships available in the way of floating supports; but he carries out the plan further, and proposes to construct the chairs and seats strictly according to the method which will afford the best support. He has favoured us with nearly sixty sketches illustrative of his designs, some of which have been actually tested.

Fig. 3 is an elevation, one-twelfth the actual size of one of the simplest of his buoys, in the shape of a deck stool. In its present position,

it appears as arranged for deck service, the top forming the seat. The upper and lower divisions, A and B, are hollow water-tight cases, hinged together on one side, and fitted with connecting hasps on the other. When intended for use in the water, the hasps are unfastened, and the party about to trust to its aid, enters it on the open side, and secures it beneath his shoulders by again fastening the hasps. A short bar, C, is slung by cords from each side of the opening, and answers as a seat, whilst the feet are supported by a similar bar slung below them. A small paddle slung loosely at each front corner of the stool, provides the power of propulsion.

Fig. 3.



The remaining designs are for the most part modifications of this arrangement—many of them exhibiting great ingenuity in their construction. One of these, in the form of a rectangular frame, fitted with air-tight vessels and paddles, has been tried at various times by the inventor. A representation of it is to be seen in a view of the launch of the "Forth" steamer, about seven years ago, when Mr. Taylor personally exhibited the capabilities of the plan. The model in our possession is a species of solid timber raft, fitted with out-riggers for the support of parties who may either have air pillows attached to themselves or to the raft. Many of the articles have been tried in Lochend and in Duddingstone Loch, near Edinburgh, and the inventor has crossed the Forth from Leith to Burntisland, and visited Inch Keith, an island in the Frith of Forth several times, with no other assistance.

The practical difficulty attending the use of floats of this kind, is their liability to get out of order when most wanted. The waterproof pillow coverings must wear, and very slight injuries will be sufficient to annihilate their sustaining power. The same remark may be made with reference to Mr. Taylor's hollow vessels and frames; for, after knocking about the decks and cabins of a ship for months or years, the chances are, that their buoyant power will be annihilated. Still there are innumerable methods of turning to account the moveables of ships, which might be acted upon with little difficulty, without producing much interference with the legitimate office of the articles so modified.

Dr. Scott's waterproof coverings appear to present fewer objectionable features than any which we have noticed; but whilst we credit him for the extension of the idea, it is necessary to mention the valuable endeavours of an earlier hand. The facetious George Cruikshank, some years ago, made use of the pages of his "Table-Book" for the promulgation of the same plan. In the earlier portion of this volume of fun, the veracious Captain Cutaway, who was, doubtless, a near relative of Munchausen, gave a sparkling detail of his adventures amongst the Chinese, and, amongst other matters, mentioned their remedy for shipwreck. Each junk carried a number of triangular or square stools, formed of three or four hollow pieces of bamboo, joined together in a frame, and supported on three or four legs. The joints being made waterproof, the frame afforded an excellent support for the shipwrecked mariners, who got inside it, and rested upon a pendant strap, hoisting their umbrellas for sails. In a subsequent paper by Mr. Cruikshank, on the prevention of accidents, he referred to the means pointed out by the gallant captain, and proposed the plan of waterproof coverings now before us.

OUTLINE OF ASTRONOMY.

No. II.

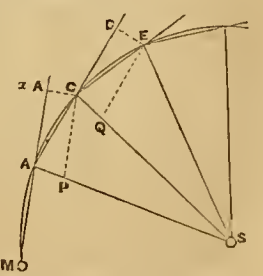
Gravitation is the effect of a force universally spread throughout nature, residing not only in the globe, but in every other known species of matter. The first phenomenon observable in the gravitation of terrestrial bodies, is the swiftness with which they fall to the ground. All bodies, whether great or small, and whatever may be their size, weight, or density, begin falling at the rate of 15 feet per second; in the next second, three times as much space is passed through; in the third, five times as much, and so on; the spaces traversed in a consecutive number of seconds, being in the arithmetical proportion of 1, 3, 5, 7, 9, &c. From this it follows, that the total space passed through at the end of any given second, is equal to the square of the number of seconds elapsed from the commencement of the descent, multiplied by 15. Thus, a body which has occupied 10 seconds in its descent, will have passed through ($10 \times 10 \times 15 =$) 1500 feet. Galileo first promulgated this law, and it is confirmed by the fact, and proved by the very nature of the thing. Gravity being a continued force acting continuously upon the body submitted to its operation, during the whole period of that operation, it follows that the space passed over will be as the square of the time.

The earth is a round body, and gravitation operates at every point, and consequently at opposite points, of its surface. The rotundity of the figure is a consequence of this force, because all the parts are attracted to one common centre, and about this centre they arrange themselves so as to preserve the equilibrium of the whole. The same force is operating in all the planets, as is proved by their spherical figures; and we may conclude that all bodies whatsoever, no matter what their distance from us, are also subject to its operation. The ideas which led to the famous Principia of Newton, were first entertained by him in 1666. The principle had been early recognized, that a body thrown into motion will continue to move in a straight line, until it meet with an impediment, and that a body sent into circular motion will make its escape by a tangential line, the moment it is freed from constraint. The planets would fly off in tangents; that is, would continue their courses in straight lines, prolonged indefinitely, if they were not retained by that central force; in other words, by that attraction which prevents their escape, and binds them to their orbits like the cord of a sling. Newton compared the force which the earth exercises upon bodies, with that which keeps the moon in its orbit, or which hinders it from flying off in a straight line by the centrifugal force. Bodies descend to the earth, as we have stated, with a speed of 15 feet in the first second; but the moon's orbit is only bent by the attracting power of the earth, the 240th part of a foot in the same interval of time, that is to say, 3600 times less. Now, the moon is 60 times farther than we are from the earth's centre, and the square of 60 is just 3600. Thus, the hypothesis that the same force diminishes as the square of the distance, suffices to explain both the descent of heavy bodies to the earth, and the revolution of the moon round that planet. We see, then, that this force diminishes in intensity, at a greater ratio than the distance increases; at a distance 10 times as much, the attraction is 100 times less. This is what is meant when we say, that attraction is in inverse ratio to the square of the distance.

We will now show how we arrive at the curve of the moon's orbit in a second of time. We have just said that this curve is the 240th part of a foot in a second. Now, the divergence of the tangent increases as the square of this time. In 60 seconds, or one minute, it will be 3600 times greater, or 15 feet; in an hour, it will be again 3600 times greater, or 54,000 feet; in 24 hours, or one day, it will be 476 times 54,000 feet, or 5550 miles; in seven days, it will be 49 times greater, or 270,000 miles, which is, in fact, the radius of the moon's orbit.

In order to obtain the curve of the earth's orbit, we make the same calculation; thus, the sun, with a radius of 465,000 miles, causes bodies to fall at its surface at the rate of 420 feet per second; at a distance 202 times greater (the earth's distance), it will cause them to fall 202×202 times less rapidly, or at the rate of the hundredth part of a foot per second. To obtain the curve in a minute, we must multiply this fraction by the square of 60 (number of seconds in a minute), and we shall have 36 feet. Now, multiplying this sum by the square of 60 (minutes in an hour), we shall have 130,000 feet; multiplying this sum by the square of 24 (hours in a day), we shall have 12,900 miles for the fall during a day. Finally, multiplying that number by 90 (days making three months, in which time the earth completes a quarter of her annual revolution), we shall have 102 millions of miles, which is equal to the radius of the earth's orbit; and that result proves, that the hundredth part of a foot is the curve, or the versed sine of the earth during a second, and that the solar attraction acts in an inverse ratio to the square of the distance, and in a direct ratio to the mass.

To conceive the effect of the attractive force, suppose a globe, M, projected into space, and it will describe the right line, M A. But imagine that, on arriving at A, it receives an impulse which drives it towards S, in such a manner that the two forces both influence it at the same time, the one in the direction of A *a*, the other in the direction of A S. By the principle of dynamics, we know that the moving object will take an intermediate path, A C, which we determine thus: take the parts A C and A P, such that if the globe had received one impulse merely, it would have described these parts in



equal times—complete the parallelogram A A C P, and the globe, by the simultaneous action of two forces, will describe the diagonal A C, and will reach C in the same time that it would have taken to arrive at A or P.

But if at C a new impulse in the direction of S be given, the line of motion will be again changed. A second parallelogram, D Q, gives the direction C E, and so forth. It seems then that the body will describe a regular polygon, by virtue of the original impulse being modified by a series of impulses directed towards the centre, S, and exercised at equal intervals of time. If such impulses are continually repeated, we are led, conformably to Kepler's first law, to the notion of a curvilinear motion. If it should happen that the central forces cease to operate, that instant the object would fly off in a right line, which would be a tangent to the curve it was moving in. When the two forces, A C and A P, that is, the centrifugal force or compulsion, and the centripetal force or attraction, increase proportionally, the direction, A C, of the motion continues the same, but the speed increases as the forces are increased, and the motion is circular and uniform; but if one of the forces is increased in a greater degree than the other, then the motion will be neither circular nor uniform. Let us suppose that the central force becomes, or was in its origin, a little greater than the force of impulsion, the path, A C, C E, will be drawn nearer the centre, S, and the speed will acquire more rapidity, since the two forces, instead of contending, will operate almost in the same direction. By calculation, and by experience, we prove that attraction increases in an inverse proportion to the square of the distance—in other words, that, at a distance three times less, the attracting power is nine times as great; and we find, also, that the centrifugal force increases in an inverse ratio to the cube of the distance—that is to say, that, at a distance three times nearer, the force is twenty-seven times more powerful. Therefore, the planet will approach the sun until it reaches the point at which the arc of its orbit becomes perpendicular to the radius vector, the speed will be increased to a greater degree than the attracting force, and the planet will begin to recede from the sun. This receding will continue until the attraction, acting inversely to the impulsive force, and diminishing in a proportion less than it, will become in its turn preponderant, and the planet again commences its approach to the sun.

It is evident that, under the influence of these forces, the planet will not describe a circle, but an ellipse. The nearer it may be to the sun, the more rapid will be its motion; when most distant, its motion will be slowest, but in such a proportion that the areas described by the radii vectores will be equal. (See the diagram in our last article.) It will be clearly seen, that in order to have the areas or the surfaces of the triangles within the ellipses equal to one another, it will be necessary to have the arcs subtended by them longer at one time than another, and consequently that a planet, in describing the ellipse, will have a more rapid movement at its perihelion than at its aphelion.*

The force with which a planet is attracted does not depend upon its mass, because we find that in a vacuum small bodies fall with the same speed as large ones. We find also, that if a single particle of matter is attracted in any degree whatsoever, all its parts will be attracted equally, each part being acted on independently of the others; and thus we see that the power of attraction has reference only to the attracting body, not to that on which its influence is exerted. When we know the mass of a celestial body, it is easy, in comparing it with another, to find its power of attraction. For instance, the mass of the sun is 354,936 times more considerable than that of the earth, and its radius is 111 times greater. Dividing 354,936 by the square of 111, we obtain a quotient of 28 nearly, and thus we find that the attraction of the sun on bodies at its surface is 28 times greater than that of the earth on terrestrial bodies, and that, instead of passing through 15 feet in the first second, they will pass through 428 feet.

The mass of the planets, that is to say, the quantity of matter they contain, may be ascertained by means of the principle of attraction. This may appear singular, but it is a natural consequence of the law of gravitation, since the attractive force is a certain index to the quantity of matter. Let us take, for a term of comparison, the mass or the attractive force of the earth, the effects of which are familiar to us, and let us inquire what is the mass of Jupiter with reference to that of the earth. The first of Jupiter's satellites performs its revolution at a distance, which is within a tenth of the moon's distance from the earth. If that satellite turned round Jupiter in the same space of time that the moon takes to turn round the earth, it would follow that the power of Jupiter to retain his satellite in his orbit, would be equal to that of the earth to retain the moon in hers, and that the mass of Jupiter would be the same as that of the earth—in which case it would result, that the density of the earth was 1470 times greater than Jupiter, since it would produce the same effect with a volume 1470 times less. But if the satellite moves 16 times quicker than the moon, 256 times more power would be required to retain it, because the central force is as the square of the speed. Now, 256 is about five times less than 1470; therefore, the volume of Jupiter is five times greater than his quantity of matter compared with the earth; in other words, the density of the earth is five times greater than that of Jupiter. By this method of calculation, Newton found the masses and the densities of the planets; and the rule, taking the mass of the sun as unity, may be expressed generally thus: the mass of a planet is to that of the sun as the cube of the distance of one of its satellites, divided by the square of its sidereal revolution, is to the cube of distance of the earth from the sun, divided by the square of her revolution. Thus, the fourth satellite of Jupiter is 1,267,000 miles from that planet, and it makes its revolution in 16 days 18 hours. Cubing the distance of this satellite, and dividing the result by the square of its revolution, we shall obtain a number which is nearly the 1054th of that obtained by the cube of 95 millions (distance of the earth from the sun), divided by the square of 365 days, the duration of its sidereal revolution. This fraction, a 1054th, is the mass of Jupiter, compared with that of the sun. In the same way we shall find that the mass of the earth is the 354,936th of the sun's, by ascertaining how many times the cube of the moon's distance, divided by the square of her revolution, is contained in the cube of the distance of the earth's distance from the sun, divided by the square of her annual revolution.

The number representing the *mass* of a planet being divided by its volume, expresses the *density* of that planet compared with the sun. Thus, the mass of the sun is 354,000 times that of the earth, its volume is 1,400,000 times larger; dividing the first number by the latter, we obtain the fraction $\frac{1}{5}$, which represents the density of the sun, that of the earth being 1; in other words, the earth is five times more dense than the sun. These proportions of density we may compare with familiar objects. Wood is ten times lighter than iron; it is the density of Saturn compared with that of the earth. Stone is five times lighter than copper; that is about the density of the sun relatively to that of the earth's. It must be observed, that the densities of Mercury, Venus, and Mars, are not to be found by this method, inasmuch as these planets have no satellites indicating to us the amount of their attraction. It is only by the perturbations they occasion to other bodies, that we are able to make an approximate calculation.

Density of the heavenly bodies compared with the earth.

Sun,	0.25484	Jupiter,	0.2580
Moon,	0.742	Saturn,	0.10422
Mercury,	2.583	Uranus,	0.2204
Venus,	1.0379	Neptune.	
Mars,	0.6506		

When we know the mass and the diameter of a planet, it is easy to find the effect of gravity at its surface; that is to say, the force with which heavy bodies are precipitated towards the planet; since that force bears a direct ratio to the mass, and is in inverse ratio to the square of the radius. It is, in fact, the rate of speed of terrestrial bodies, multiplied by the mass of the planet, and divided by the square of its radius, taking for unity the mass of the radius of the earth. For instance, bodies falling to the earth, pass through 15 feet in the first second; multiplying 15 by the mass of Jupiter (256), and dividing the product by 121, square of its radius (11), we obtain a quotient of 32, and that is the number of feet which bodies near the surface of Jupiter run through in a second, on commencing their descent.

Such is the solution of some of the problems of astronomy, which were unapproachable before the discovery of Kepler's laws and those of attraction. We shall afterwards see that the obliquity of the ecliptic, the precession of the equinoxes, the nutation of the earth, the aberration of the stars, the ebb and flow of the ocean, and other phenomena, which seem anomalies, and to contradict the mathematical rules of nature, are in fact derived from this universal law of gravity, which binds, preserves, and harmonizes the universe.

We will now proceed to a consideration of the individual bodies which form the planetary system.

THE SUN.

The planetary system is composed of twelve planets, circulating round a central orb. These planets are named Mercury, Venus, the Earth, Mars, Vesta, Ceres, Pallas, Juno, Jupiter, Saturn, Uranus, and Neptune.

After the diurnal movement, one of the most striking phenomena concerning the sun, since it produces the differences of season, and the length of day and night, is its periodic or annual motion. This motion

* *Perihelion*, that point in a planet's orbit where it is nearest the sun; *aphelion*, the reverse.

is only apparent, as we have shown in our exposition of Copernicus' system, but we shall here examine the appearance of the phenomena on our planet, before alluding to the causes. In order to be convinced that the stars are immoveable, and that it is the sun which daily moves a degree or thereabouts towards the east, it is sufficient to observe that it changes continually the points of its rising and setting, whilst the stars invariably rise or set opposite the same terrestrial objects, and retain the same relative position. To measure this movement with precision, we may observe on a clock, regulated by the stars, the passage of the centre of the sun across the meridian, and we shall find that it arrives there about four minutes later than a star taken at pleasure, as an object of comparison. When the earth has performed 90 revolutions, the interval is nearly six hours (90×4), therefore the horary circle of the sun advances 90 degrees farther east than that of the star. After 180 revolutions, the sun crosses the meridian 12 hours after the star, and its retardations continuing to accumulate, we find that, after 365 days and a quarter, it has accomplished its annual revolution; that is to say, that it has made the entire circuit of the ecliptic, and has returned to the same point of the heavens as the star which has crossed the meridian once oftener, precisely in the way that a traveller who has made the circuit of the globe reckons a day more than we do, if his course has been directed eastward. This annual motion from west to east, the reader will be aware, is contrary to that diurnal motion common to the whole heavens, and which we have previously explained.

The path apparently described by the sun in this annual motion is a circle called the *ecliptic*. It is different from the equator, which is placed at an equal distance from the poles. It cuts the equator at two points, and then separates from it north and south, to the extent of 23° 28′. Now, we want to determine in the celestial vault, and amongst the fixed stars, the route or path of the sun, and to observe the stars by which it must pass each day of the year. For this purpose we must first notice that there are two days in the year, separated by six months from each other, when the sun has 57° of meridian altitude. These two days are termed the equinoxes, because the sun, describing the equator, and being then 12 hours above and 12 hours below the horizon, day and night are equal. One is called the equinox of spring, the other of autumn. Having observed on the day of the spring equinox, what star or what point of the heavens crossed the meridian at midnight, at the same altitude as the sun, that is, of the altitude of the equator, we are sure of knowing the point opposite to the sun, that is, the autumnal equinox, and the place where the sun will be found six months later. A similar observation at the autumnal equinox being made, and we shall then know two essential points of astronomy. The points of the ecliptic situate between the equinoxes, where the sun has reached its greatest distance from the equator, have been named solstices, and these occur about the 21st of June, and the 21st of December.

In order to measure the movements of the sun and the other celestial bodies, it became necessary to select some fixed point in the heavens from which to set out, and to which everything can be referred. The return of the seasons, for man the most remarkable and interesting fact in all astronomy, fixed this. The sun by its annual courses restores verdure to the fields, and their renovation of nature serves to mark the commencement of the year, and astronomers make use of it to begin their measures at the point when the change commences, namely, at the point where the ecliptic and the equator intersect. The distance of the sun from the equinoctial point, reckoned along the ecliptic, is termed its longitude. When the sun has run through 30° of the ecliptic, starting at the equinox, we say that it has passed over one sign of longitude, and each succeeding 30° form another sign, until the whole are passed through, and it arrives at the point it set out from. The first 30° are comprehended under the name of the Ram, the next 30° of the Bull, after which follow the Twins, the Crab, the Lion, the Virgin, the Scales, the Scorpion, the Sagittary, Capricorn, Aquarius, and the Fishes. These twelve signs into which the ecliptic is divided, are to be distinguished from the constellations which bear the same name.

When the equinoxes and the solstices had been ascertained, and the stars to which the sun successively advanced in his annual course had been observed, it was not difficult to perceive that it required 365¼ days to return to the same point, but it required centuries of observation to determine that the exact time occupied was 365 days 48′ 48″. Such is the route apparently traced by the sun in the heavens when looked at from the earth. If we beheld that luminary from the planet Mercury, its motion would appear four times more rapid; whilst from Uranus, we should see it complete its revolution only after a lapse of time 75 times as long.

But though the sun does not move round the earth, we must not take it for granted that it is motionless in space. We have before remarked, that the heavenly bodies attract in proportion to their mass, and in a ratio inverse to the square of the distance. It is true that the mass of the earth is only the 354,000th part of the sun, but it must act upon the sun as well as the other planets, in the proportion of that mass, and it will displace the sun from the point which it occupies, and cause it to describe an ellipse. This ellipse will be small indeed, since Newton calculated that if, by an unlikely combination of circumstances, all the planets should be in conjunction (that is, all on the same side of the sun), so that their united powers of attraction should be exerted in the same direction, they would not be sufficiently powerful to cause the great axis of that ellipse to exceed the radius of the sun.

And not only does the sun move in an ellipse round the common centre of gravity of the planets, but it has a rotation round its own axis every twenty-five hours and a half; and since we are led by analogy to believe that no body turns on its axis without advancing, we must suppose that the sun itself has a translation in space. Observations have been made, and if they are correct, they show that the sun is being carried through space with astonishing rapidity, taking along with him the whole planetary system. The sensible increase of light perceivable in the stars of the constellation Hercules, indicates that the direction of his travels is towards that point.

The surface of the sun is frequently seen to be covered with dark spots of an irregular and changing form. Sometimes they are numerous and extensive. In the year 1836, some were visible that were equal to eight or ten times the diameter of the earth. At other times the sun appears clear and without a single spot, and this for a whole year together. It was these spots which led to the discovery of the sun's rotation.

We know that the mass of the sun is 354,000 times that of the earth, and we shall see how we calculate that its diameter is 110 times that of our planet, and its volume 14,000,000 times more considerable. The apparent diameter of the sun varies in the course of a year; but this change is the result of the earth's varying distance from the central orb, which, it will be recollected, occupies one of the foci of an ellipse described by our planet. It is remarkable that, in our hemisphere, the sun is nearer us in winter than in summer, by three millions of miles; but in the latter season, the sphere being oblique, the sun is elevated only a little above the horizon, and has not time to warm the atmosphere.

STEAM SAW FOR CUTTING RAILWAY BARS.

Illustrated by Plates 17 *and* 19.

The rotatory emission engine is peculiarly fitted for propelling light machinery at high speeds, and to this end it has found a most successful application in driving the circular saws for cutting railway bars. The example of engine which we have chosen for our illustrations, is by Mr. Nasmyth of Patricroft, who has introduced several improvements upon the original four-armed wheel.

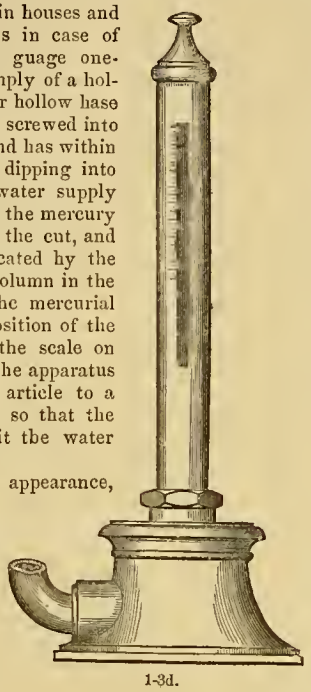
Fig. 1, Plate 17, is a complete longitudinal section of the steam wheel, with its frame, saw, and foundation plate; fig. 2, is a corresponding plan; and fig. 1, Plate 19, is a transverse section through the wheel and waste steam case. The wheel, A, is a hollow open disc, with a loose side, B, checked into it, and bolted down by nine bolts. The hollow saw shaft, C, is cast in one piece with the wheel, and is carried in the long bearing of the double pedestal, P P, which is bolted down to the foundation plate, D. The contrary side of the steam wheel is steadied upon the conical bearing, E, on the end of the supplying steam pipe, F, which rests between the adjustable centre, G, of the back pedestal, and the conical aperture in the centre of the side plate, B, of the wheel. The arrows show the passage of the steam into the wheel by the pipe, H; and the escape of the waste steam and condensed water by the upper and lower pipes, I and K, connected with the outer casing of the wheel, L. A compensating spring is cleverly arranged in a prolongation of the steam pipe, F, to counterbalance the pressure of the steam upon the area of its ingress opening at M. A helical spring, N, is placed in the open end of the pipe, so as to abut against the closed end of the pipe, M. This spring is acted upon by a short sliding block, urged forward by the adjusting centre, G; in this way it is compressed to such an extent, that its reaction will just compensate for the steam pressure upon the supplying area, and so prevent the possibility of undue friction upon the conical joint of the side plate of the steam wheel.

The waste steam case, L, is cast in two halves, bolted together at the centre, by means of side lugs, the whole being firmly bolted by flanges at the bottom, to the base plate, which has a steadying rib cast on it to fit the interior of the lower edge of the case. The saw, O, is secured to the shaft, C, by a long bolt passing up its centre, the external nut upon which holds a stout washer hard up against the saw plate, which bears against a collar of similar size, cast on the end of the shaft. The total area of the four steam apertures is 1½ square inches; steam pressure,

60 lbs.; revolutions per minute, upwards of 2,000. The time taken to cut a bar of the average section is 10 seconds, and it is to this limited period of aetion, that this species of steam propeller owes its peculiar fitness. For although the wheel has in reality very little power, yet its great speed admits of a large accumulation of momentum hetween each sawing action, and practically gives it ample power for tbe 10 seconds duration of work.

HYDROSTATIC INDICATOR OR PRESSURE GUAGE.

Messrs. Lynch and Inglis, engineers, of Manchester, have recently introduced and registered a convenient instrument for ascertaining the supply of water which may be contained in the over-head cisterns, usually provided in houses and factories, as a precautionary means in case of fire. Our wood-cut represents the guage one-third the actual size. It consists simply of a hollow column, supported upon a circular hollow hase containiug mercury. The column is screwed into the top of the cup forming its base, and has within it a glass tuhe, open at the bottom, dipping into the mercury. The cistern whose water supply is to be indicated, is connected with the mercury cup by a pipe attached, as shown in the cut, and the height of water is exactly indicated hy the corresponding rise of the mercurial column in the glass tuhe. As the standard of the mercurial column will vary according to the position of the guage with referenee to the cistern, the scale on the columnar case is graduated after the apparatus is fixed, or, in case of sending the article to a distance, a moveable scale is fitted, so that the zero point may be arranged to suit tbe water column.



1-3d.

The guage has an extremely neat appearance, and as it can he placed in any convenient locality where a pipe can be led from the cistern, it may he opeu for inspection to all parties, and will certainly prevent all misunderstanding as to the available supply of water. In this respect it possesses many solid advantages over the usual float and pulley arrangement.

ON MOMENTUM.

By John Curr, Esq., of New South Wales.

Three rules are propounded for finding the momentum of a body in motion, each one differing from the other. At the London Institution it has been ruled, that tbe quantity of matter multiplied hy the height it falls in feet, gives the *exact* momentum. At the Royal Military Academy it has long been taught, that the momentum is equal to the weight multiplied by the square of its velocity; and it seems a self-styled Club of Artisans has recently put forth, that the mass or quantity of moving matter, multiplied by its velocity in feet per second, gives the actual force of impact, or the momentum.

Of these rules the first differs from the last as 1 to 2, and from tbe second as 1 to $64\frac{1}{3}$. Each of them has been enunciated by Dr. Hutton, who indeed cared little for truth or reasou, provided his symbols looked *plausible*.

The "Practical Mechanic's Journal" has had the pertinence to show up their absurdity; and if it continues tbe course it has adopted, taking truth as its guide, without looking to the right or left, it will he entitled to the patronage of the present, and tbe respect and gratitude of future, generations. In Part I. page 4, the "Journal," iu reference to the last of the above rules, says—"If we were to take feet per minute instead of seconds, or inches instead of feet, (and we do not know why we should not, seeing that we should still multiply the mass by the velocity,) the momentum by *rule* would he most considerahly increased;" a fact which no rational member of the Artisan Club can dispute. It would be a laxity of justice not to mete out to the editor of the "Journal" his due portion of merit, for his resolve to sweep out of the Augean school of mechanics one of the most obstinate of its blunders, and which, in fact, has been so long hroached, as almost to have acquired, in the minds of civil engineers, the authority of a prescript.

It has heen shown, in the "Practical Mechanic's Journal," that the momentum of falling bodies of equal weights is proportional to the heights fallen through, or as the square of the velocities. Hutton said the same; hut he forgot himself when, intending to show up Belidor's errors in pile-driving, he made the momentum not only proportional, but *equal*, to tbe square of the velocity of the ram, multiplied by its weight.

As mathematicians are not in possession of any fact or law by which to show, that space, in determining velocity and momentum, is necessarily to he measured in feet, and time in secouds, the momeutum is determinable only hy the following or such like experiments, wherein the momentum of a moving body is made equal to the weight or pressure of some other body at rest.

Exp. 1.—Let any mass of bard matter of known weight fall on the head of a pile; let the pile he thereby driven into some homogeneous non-elastic matter, as clay, the operation being repeated until the pile ceases to sink, or until the sinking becomes imperceptible; when tbe greatest height which the mass has fallen, is to be measured in feet.

Exp. 2.—Place on the head of a similar pile of the same suhstance, weight, and length, so much weight as will gradually sink it the same depth in similar matter as in Exp. 1. From such weight deduct tbat of tbe pile, and tbe difference is equal to the momentum of the matter or body used in the first experiment.

Then let tbe weight of the matter used in experiment 1, be reduced to pounds, which multiply by the number of feet it bas fallen, and by the product divide the momentum (also in pounds) as found in experiment 2, and the quotient is the actual momentum of 1 pound falling 1 foot $= m$.

When the momentum, M, of a mass exceeding 1 pound, w, and falling a greater height, h, than 1 foot, is required, then $\text{M} = m \times h \times w$.

When the velocity, v, of a moving hody is given in feet per second, and whether the motion be perpendicular or horizontal, $\text{M} = m \times w \times \frac{v^2}{64\frac{1}{3}}$.

The consideration of momentum is of especial use in this engineering era of the world, in pile-driving, and railway coneussions—in civil, and in determining the effect of a cannon ball in military, engineering—wherefore the following

Specimen of the Uses and Applications of the Preceding Formulæ.

In Pile-Driving.—First: The value of M should be not less than three times the actual weight the pile will be required to support. Second: The value of M should not exceed one-third the weight, or resistance to crushing, tbat the pile would sustain (according to the matter composing it), as appears by the experiments of Mr. Tredgold, or of some other experimentalist. Third: Tbe greater the weight of the ram, so that M does not exceed the limits just given, tbe greater will be the effect produced by a given quantity of power or labour.

In Concussions on Railways.—If every train were attended by two machines, as invented by Sir George Cayley, the one in advance, and the other in tbe rear, of the train, the weight and velocity of the train being given, and the diameter of the cylinder of the machine, so that tbe resistance it can withstand he M, and the length of the cylinder proportioned also, as might he determined by experiment, the passengers' engine and train would be saved harmless, when the weights and velocities of both trains are the same; and in other cases the effect of the concussion would be greatly reduced.

The Momentum of a Cannon Ball.—First: When its weight and velocity are given, the momentum would be found by tbe above formula. Second: If the strength of an iron ship or vessel struck by any hall be less than the momentum of such hall, it will penetrate the vessel, if the joints of the plates be eqnal in strength to the iron composing them. If the joints he of less strength, an entire plate would be removed by each ball. A preventive of both is suggested as follows:—First: Let a vessel be built of iron, having an external and internal shell, and with an interval of 4 or 6 inches. Let the interval he filled with water, and the effect of the shot on each plate would he redueed inversely, as 1 plate to the numher of plates in contact with the said water, or as 500 or 1000 to 1, according to the size of the vessel; and the momentum of a 56 lb. ball, supposing the number of such plates to be 500, would be reduced to that of a ball of 2 ounces weight. The additional cost of a frigate 200 feet long would be about £3000. Second: If a vessel so constructed were stranded, it seems the damage would he very greatly reduced, as the rule in one case applies to the other. Third: The absolute effect of a cannon hall beiug found at any velocity, as that occurring in the perforation of the side of an oaken ship, and making therein a round orifice of the diameter of the ball, the momentum of another and heavier ball moving at a less velocity may be found; so that its effect would be to bulge inwards a large surface of the ship's side, which would be irreparahle, as, if struck near the water, the ship would soon go down. Fourth: If a double-cased iron steam-vessel of 100 tons burthen, and carrying only three or four hands, were properly constructed, and the upper-deck *roach-backed* (instead of being flat), so as to deflect a shot, and if she were impelled through the water

according to a principle elsewhere described by the writer hereof, in nine cases ont of ten an enemy's ship would he sunk, without any loss of men or damage to the iron steam-vessel. Fifth: To enahle a steam-vessel of so small a hurthen to hear the shock of so large a gun as would be requisite, it is enough to say that a contrivance is practicahle; so that the momentum of the gnn would be the same whether the shot he 1 lb. or 1 ton weight.

Should this article fall under the observation of Government, it cannot fail to observe, that the momentum of a ball has heen established, so that theory and practice shall inevitably agree; whilst Hutton's theories on the same suhject are useless.

If the method whereby a shot may be impelled by gunpowder, so that the momentum of the gun be obviated, however heavy the ball, and however light the gnn, is deemed valuahle, the writer hereof is willing to communicate the invention to the Government, and without fee or reward.

ANATOMY OF THE PHYSICAL STRUCTURE OF THE UNIVERSE.

By Mr. R. Smith, Blackford.

V.—Light.

Our fonrth chapter explained the fact, that polarized light nearly ceases to be reflected when the glasses are placed at right angles to each other, bnt it yet remains to be mentioned, that the small portion of light still observable is of a pnrple tint, when tbe reflecting surface is glass, and a beautiful blne when oil of cassia is the reflector; and that the colour varies according as the angle of reflection is above or helow the polarizing angle. In explanation of these phenomena, Sir D. Brewster ohserves, that different rays have different indices of refraction in every substance, so that, according to the general law, they must also have different angles of polarization. When the experimeut is made with homogeneous light, the nnpolarized portion disappears when the position or angle is such as to polarize the blue light; in this position the red light is not polarized, and when it is, the blue is not, as will be apparent upon referring to the following table:—

PLATE GLASS.

	Indices of Refraction.	Polarizing angle.	Variation.
Red Rays,	1·515	56° 36′	19′
Mean Rays,	1·525	57° 45′	
Violet Rays,	1·535	57° 55′	

OIL OF CASSIA.

Red Rays,	1·597	57° 57′	24′
Mean Rays,	1·641	58° 39′	
Violet Rays,	1·687	59° 21′	

WATER.

Red Rays,	1·330	53° 4′	15′
Mean Rays,	1·336	53° 11′	
Violet Rays,	1·342	53° 19′	

Sir D. Brewster discovered that light could be polarized at any angle of incidence, if snbmitted to a snfficient number of reflections, and that it may be effected in varions ways—as hy snccessive reflections from glass plates, arranged so that they may form the circumference of a polygon, each plate receiving the reflection from the one preceding it.

In polarizing by snccessive reflections, it is not essential that all the reflections should be made at the same angle; 62° 30′ is above the polarizing angle, and at this point the incident ray is polarized, as well as at 50° 26′, which is below the polarizing angle.

When a ray of light falls npon the upper layer of a stratnm of glass-plates, at the polarizing angle, the transmitted ray which passes through the plates is polarized as well as the reflected ray. Consequently, if a ray of light falls npon the surface of a transparent body at the polarizing angle, the reflected ray is completely polarized, and a nearly equal quantity of the transmitted ray is polarized, in a plane at right angles to the polarization of the reflected ray. Arago has come to the conclusion, that the polarization of the reflected ray, and that of the transmitted ray, are exactly eqnal to each other.

The most beautifnl experiments within the pale of optical scieuce, are those which exhibit the phenomena of colour, caused by the action of crystallized substances on polarized light. With the polariscope arranged, as in onr last chapter, to reflect the clear light of the sky, or of a candle covered with a glass shade, if a piece of mica is placed on the stage, upon looking into the analyzing plate, we observe, instead of the image of the sky, an image of the mica, covered with a glow of colours of the greatest variety, following each other in snccession according to the different inclinations of the mica sheet, and depending also in some degree upon the varying thickness of the material.

Place upon the stage a film of sulphate of lime, of a thickness sufficient to produce a red tint, and, with the analyzing plate quite stationary, make the film revolve round the polarized ray from any position where colour is absent; and it will be observed that the brightest or maximum of colour takes place at the azimuths or angles of revolution of 45°, 135°, 225°, and 315°, whilst the colour vanishes at the angles of 0°, 90°, 180°, and 270°. Then fix a film at 45°, or at any other angle where the greatest brilliancy of colour occurs, and when the analyzing plate is turned round, the brightest red will appear at 0°, gradually diminishing in intensity, until it reaches 45°, when the red colour will disappear, and a faint green tint will gradually take its place, increasing in brightness until it reaches 90°, when it heeomes fainter, and finally disappears at 135°, at which point it is again succeeded by the red, which reaches its brightest point at 180°. The same changes oecur betweeu 180° and 360°, and between 360° and 0°.

If a film of sulphate of lime producing different colours is substituted, it will be seen that the two are complementary to each other, and that they produce together white light. Upon analyzing the light derived from the film, hy means of a rhomb of Iceland spar, instead of the analyzing plate, this phenomenon is exhibited in a heautiful manner. One of the faces of the rhomh is screened off, and a circular aperture is made in the covering, just so large that the two images viewed through the rhomh, over-lap each other. When the plane of the main section of the rhomh is in the plane of primitive polarization, one image will be green, and the other red, whilst the overlapping portion is white.

The colours produced hy the action of films upon polarized light, vary according to the thickness of the film used. If two films are placed together in the same position in which they lie in the crystal, they will produce the same effect as one which is equal to the united thickness of the two. But if two plates are made to cross each other, they destroy each other's action, and blackness results; and if two films of unequal thickness traverse each other, they produce a tint equal to the difference of their thicknesses.

The following tahulated list shows the ascertained effects which films of various thicknesses have upon polarized light:—

Thickness of Films.	Colours.
0.00046	No colour.
0.00124	White, first order in Newton's scale.
0.01818	White, composed of a mixture of all the colours.
From 0.00124 To 0.01818	All the different orders of colours in Newton's table.

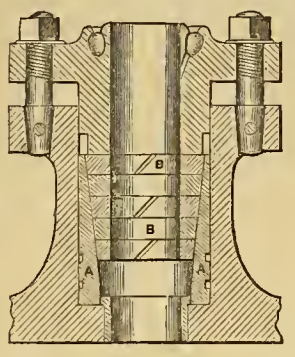
These phenomena may be seen to advantage in an experiment devised by Sir D. Brewster. A film of sulphate of lime, varying in thickness from $\frac{1}{25}$th of an inch, down to the thinnest possible edge, is placed upon the stage of the polariscope, and the image on the analyzing plate is covered with coloured fringes, parallel to the thin edge of the film, exhihiting at once all the colours of Newton's table, and showing that different thicknesses produce different tints.

Amongst the most splendid representations producible by polarized light, are those oecasioned by unannealed glass. If a square piece of crown glass is heated, and suddenly cooled, it will present an appearance similar to ordinary glass; hut if placed on the stage of a polariscope, with the index set at 0°, the analyzing plate will reflect a series of beautiful curves in each of the angles of the unannealed glass, the brightest tints heing red and green, whilst the centre of the piece is intersected hy a white cross. When the indeх is moved to 90°, a different series of colours will appear complementary to these, and the white cross will be replaced hy a black one. Sir D. Brewster has shown a beautiful method of exhibiting the complementary colours, by means of a gothic window, with small pieces of sulphate of lime, or mica, of various thicknesses, representing the panes of glass. When this miniature window is placed upon the polarizing stage, and viewed in the analyzing plate, it appears to be of stained glass, and when set at the different azimuths, the panes continually change their tints, forming a very brilliant spectacle. Indurated animal substances, as quills, horn, jellies, and albumen, also give out beautiful tints under the polariscope. The crystalline humour of the eye, especially that of fishes, when placed in oil of the same density, is a fine substance for the pursuit of the same experiments.

By an experimental test, the author has discovered, that when the thin portion of the scapula of a fish is placed on the polarizing stage, a series of beautifully lucid fringes, of all the colours of Newton's table, occurs at the azimuths of revolution of 45°, 135°, 225°, and 315°.

HUNT'S METALLIC PACKING FOR STUFFING-BOXES.

An ingenious metallic packed gland has recently been registered by Mr. T. Hunt, the superintendent of locomotives at the Preston station of the London and North-Western Railway. Our engraving represents a vertical section of the improved packing, as applied to the stuffing-box of a locomotive engine, and is on a scale of one-sixth the original size. The gland and cover is bored out as usual in the fitting in of hemp packing, but is lined with a hollow metal cylinder, A, bored out conically to receive a series of conical brass or tin rings, B B, each with one diagonal cut, to admit of contraction. These rings are so placed that no two cuts shall be opposite to one another, thus breaking bond and preventing the passage of any steam through. The contractive adjustment of these rings is effected simply by the screwing down of the gland, the bottom of which presses upon the upper ring of the series, and forces each ring to take a fair bearing upon the rod working through them, by the action of the interior cone. Instead of fitting in the separate conical lining, A, the box itself may be bored out conically to answer the same purpose. The arrangement appears to possess great superiority over that of hemp packing, and will no doubt work with very little friction. By forming the cone upon the exterior surface of the rings, the objectionable binding of these parts is obviated. Some years ago, Mr. Bodmer introduced a similar contrivance for applying tin rings in a cylindrical gland, and the contractive power was obtained by giving a conical inclination to the interior and exterior of each alternate ring, the whole being forced down by the gland at the top. To get sufficient acting surface, it was necessary to employ a great number of rings, and binding resulted.



THE PLANET NEPTUNE.—M. LE VERRIER'S EXPLANATION.

It is two years since I discovered the planet Neptune by means of the perturbations produced by it in the motions of Uranus. My earnest solicitations that my labours should be verified by means of a telescope were listened to at Berlin; and on the 23d of September, 1846, was begun, in the Prussian Observatory, the regular series of observations of Neptune.

I had only arrived at the position of this planet by indirect means, and without having seen it. It was, therefore, impossible that I should have attained as much precision as the direct observations of the star itself would afterwards insure. Since it was necessary that I should make use of irregularities, on which I could only depend to within a tenth of their value (as I will hereafter explain, if desired), it would have been natural that this inaccuracy should influence the positions thence deduced for Neptune, and that these positions should be liable to an error of one-tenth. But I shall make it appear that the deviation from my theory is far inferior to this tenth. Hence it will naturally result, that all assertions to the contrary are false. Without troubling myself more than necessary with the clamour attempted to be raised on this subject, I think it nevertheless my duty to take due notice of it; for if such an error should for a time take the place of truth, it would not fail to discourage deeply all those devoted to the progress of science.

"The identity of the planet Neptune with the theoretic planet," says M. Babinet, in his notice of the 21st of August last, "is no longer admitted by any one, after the enormous difference discovered between them as to mass, period of revolution, distance from the Sun, eccentricity, and even as to longitude (except at the epoch of the discovery of M. Galle, or for a very few years before and after.") If I quote this observation by the learned physicist, it is only because it sums up with infinite care all the pretended difficulties. I will go over each in particular, and reduce them successively to their real value. But I shall be permitted not to find a difficulty in the gratuitous assertion, that "the identity is no longer admitted by any one." I say that, after this discussion, no one will hesitate respecting the assertion of M. Babinet (*Personne* ne s'arrêtera au dire de M. Babinet).

Let us first fix precisely the state of the question. I have determined the position of Neptune by means of the perturbations which it produces on Uranus. Accordingly, when such perturbations take place, I can find directly where Neptune is. But when there are no perturbations, this is impossible. Let this not be forgotten. Again, the action of one planet on another depends, at a given moment, only on its relative situation in the heavens, and on its mass. The only facts, therefore, which I could conclude from the perturbations of Uranus, while they existed, were the direction in which Neptune was to be found, its distance from the Sun, and its mass. Let us see how I have arrived at the determination of these three quantities.

First: Is it true that the direction in which I have placed Neptune contains an enormous error, except for the epoch of M. Galle's discovery, or for a very few years before and after? No; this is false. I place before the Academy of Sciences a chart of the respective situations of Neptune, in the orbit I have theoretically assigned to it, and in the orbit resulting from direct observation. The latter positions have been taken from Mr. Walker, so as to avoid all suspicion of my having attempted to obtain a smaller deviation. According to this figure, the following are the minimum deviations from my theory:—

In 1857 + 4° 0′	In 1817 — 3° 1′
1847 + 1° 0′	1807 — 4° 5′
1837 — 0° 7′	1797 — 6° 8
1827 — 2° 0′	

It follows that, *during sixty-five years*, my theory, deduced from indirect considerations, assigns to Neptune a series of positions never differing from those obtained by the direct orbit by more than *one fifty-fifth*, at the most, of the circumference of a circle. And this is called a small number of years, when it is known that Neptune has had a sensible effect on Uranus for only twenty-five or thirty years at the utmost! The *fifty-fifth part* of the circle! This is what is called an enormous error, when it is known that the data which served as a basis to my theory are only known to *a tenth*. But I do not insist on this subject, as I bear M. Babinet declare, that when he spoke of *enormous errors*, he had not calculated them, and imagined them much more considerable than they are in reality. But, it will be said, if we go beyond these sixty-five years, we should find more considerable deviations. Yes, without doubt. That results from the nature of the question; it cannot be avoided. I have said that I determine the position of Neptune by means of the perturbations it produces on Uranus. When there are perturbations, I can say where Neptune shall be found; but to ask me to do so long after the perturbating action has disappeared, is simply to ask an impossibility—a sort of miracle. Now, in examining my plate—which in a few days I shall place before the public, and in which I have traced the course of Uranus—it appears clearly that this planet has been influenced by the action of Neptune only from 1812 till 1842—that is, during only thirty years.

It is then during these thirty years only that I have been able to determine directly the position of Neptune; and yet the deviation from my theory is only 3° 7′ in 1812, at the time when the action of Neptune, which then only commences, was not yet clearly determined. Then, in proportion as this action developes itself, the precision of my indications increases; and in 1842, at length, when I have at my disposal all the action of the planet, I am mistaken by no more than a fifth of a degree only—that is, by an 1800th part of the circumference—in predicting the direction in which Neptune should be seen.

Thus, far from reproaching my theory with having made the trifling error of 4° 0′ in 1807, and of 6° 6′ in 1797, it should rather be asked, how it could give with such precision the position of Neptune at an epoch when it did not act upon Uranus? In fact, this is only obtained by prolonging arbitrarily the curve which I had obtained from 1812 to 1842; a prolongation with which my object had nothing to do (*qui n'est pas de mon fait*), and which is not legitimate when pushed too far. During these thirty years, Neptune has performed only a sixth part of its orbit: an ellipse is very ill determined by an arc including only a sixth part of its extent.

During the whole of the last century, from 1700 to 1812, Neptune had in nowise acted upon Uranus. It had less influence on it than on Saturn—which it does not sensibly disturb. When I am required to say, by my theory, where Neptune was in the middle or at the commencement of the last century, I repeat it, a miracle is demanded of me.

I have then a right to say—it is false that I have committed an enormous error in the longitude at every other epoch but that of Galle's discovery, or of a few years before and after. During the whole period that Neptune has acted upon Uranus, my theory has not deviated from that deduced from direct observations by more than 1·91 of the circumference. And now it is said the discovery made by Galle is a fortuitous accident! Really, then, planets of twice the size of Uranus, and yet unknown, although shining like stars of the seventh magnitude, are scattered in such numbers over the heavens that there is nothing surprising if, on pointing by chance to any spot in the firmament, there should be great probability of finding one! And it is, no doubt, on account of their num-

bers, and because there would be no merit in discovering them, that our observers disdain to do so.

Secoudly:—Is it true that there are enormous errors respecting the distance from the Sun? No; this is false. Figures have their eloquence. Here are, according to my plate, the distances from the Sun in the two orbits for the thirty years during which Neptune has acted upon Uranus:—

	Distance in the predicted orbit.	In Walker's orbit after the discovery.
In 1812	32·7	30·4
1822	32·3	30·3
1832	32·6	30·2
1842	32·8	30·1

How is the difference of the two theories to be estimated? In reference to the distance itself, which is to be valued? Whoever, in order to strike the imagination of the public, should express this difference in post-leagues, that is, in referring it to the slowness with which we crawl upon the surface of our globe, would be following a proceeding unworthy of an astronomer. Now, in 1812, I have made an error of 1·14th of the distance; in 1822 and 1832, 1·16th; and in 1842, 1·13th—never the *tenth*, which I might have reached without being liable to any reproaches.

The direction was more precise than the distance. This might be—for if the direction had been false, nothing could have compensated for the error which would have resulted in the attraction of Neptune upon Uranus. Whilst, if the planet be placed a little too far in a given direction, the error, which would result in the quantity of attraction, may be immediately destroyed by making the planet a little larger. This is precisely what has taken place. I placed Neptune rather too far; but I made it rather too large. I might have placed it in any intermediate place, even a little too near, provided I had made it a little too small. But what am I saying? I have made Neptune too large! I forgot that this is a third objection. Let us examine it, however.

Thirdly: Is it true that the theoretic mass of Neptune differs from the mass deduced from observations of the satellite to such a degree as to be an irresistible argument against the identity of the theoretic Neptune with the observed Neptune? No; this is false. Let us again have recourse to figures. According to M. Struve, the mass deduced from the satellite is 65·100 of the mass I had predicted. But I will grant, if it is insisted on, that 52.100 must be taken; which, however, is only arrived at by choosing from among the different results obtained, that which leads to the greatest deviation. I declare, that if any one should be misled by this deduction, which corresponds only to a variation of a fifth in the diameter of Neptune, it would only be by keeping out of sight the difficulties of the same kind presented by the masses of the other planets. The mass of Uranus has been also determined by two different methods—by the action of this planet upon Saturn, and by the consideration of its satellites. Well, the second of the values thus determined is only 75·100 of the first. And yet there were forty years of direct observation of Uranus at disposal, whilst I had not a single observation of Neptune. And yet the mass only of Uranus was required to be deduced from its perturbations on Saturn, whilst I sought, from those of Neptune on Uranus, the direction, the distance, and the mass of the planet. Will it be said, then, that there are two planets Uranus? It should, to be consistent. Thus, then, the direction, the distance from the Sun, the mass of Neptune—that is to say, the only three things which might justly be required—are exact in my theory beyond all hope. The Neptune which has been found, like that which I sought, satisfies perfectly the perturbations of Uranus. This great accusation, which has made so much noise, falls back into that nothingness from which it ought never to have emerged. I might stop here. I shall conclude by considering the distance of the Sun from the Earth,—which has cost astronomers so much labour, so many journeys, dangers, and almost martyrdom. The measurement of this fundamental element of our system has presented, in the hands of the greatest astronomers, discordances greater than those objected to me. It may be obtained in two ways—by means of Mars, or of the transits of Venus across the Sun. The first method is less precise than the second; but, in return, it may be repeated as often as desired, while the second can be employed only twice in about 120 years. Mars was the first employed in 1750 by Lacaille, and by other astronomers of vast merit. They never found by this means more than 32,271,000 post leagues for the distance of the Earth from the Sun. And the agreement of the results obtained by repeated measurements gave perfect confidence in this number. Now, when the transit of Venus across the Sun occurred in 1769, a distance of 38,416,000 post leagues was obtained by means of this transit. The difference of the two results, 6,145,000 leagues, is simply the fifth part of the former. I will add, that the difficulty is not completely resolved at present. I have never had a similar difference. Should it not be admitted, then, for the sake of consistency, that there are two Suns as there are to be two Neptunes—the Sun of Mars and that of Venus?

HIGH-PRESSURE BOILER FOR M'NAUGHT'S DOUBLE CYLINDER STEAM-ENGINE.

Illustrated by Plates 18 *and* 19.

The class of boilers of which this is the type, appears to us to possess numerous features of economy, and safety in working, and may be taken as fairly representing what a good high-pressure boiler ought to be. In plate 18, fig. 1 is a longitudinal section of the boiler, with all its fittings; fig. 2 is a plan of the same, showing the flues in section, and fig. 2, plate 19, is an end elevation. The length of the boiler is 22 feet, by 7 feet 4 inches diameter; plates in shell $\frac{7}{16}$, flues and dome $\frac{3}{8}$, and ends $\frac{1}{2}$ inch; it has two internal cylindrical flues, to the entrances of which are placed the furnaces, 6½ feet long, by 3 feet wide. The flues are each 3 feet diameter, for a length of 12 feet from the front, after which they taper off to 2 feet 8 inches, as shown in the section, fig. 1, and in dotted lines in the plan; the whole of the taper being on the inside edges of the flues, in order to give a greater space between the two, for the entrance of a man to clean or repair.

The flues act most sufficiently as longitudinal stays for the flat ends of the boiler, but as the points of connection are below the centre of the ends, the upper portions are stayed from the top of the shell, by strips of boiler-plate, A A, 12 inches broad, and ½ inch thick, rivetted by angle iron at each end.

The furnace bars are $\frac{5}{8}$ inch thick, and their inner ends are set 6 inches lower than the level of the front, so as to admit a greater quantity of air, and to retain the fire as far from the crown of the flues as the size of the latter will allow. The arrows point out the direction of the current along the flues. The flame from the internal flues returns back by the side flues, B B, thence passing by the side openings, C C, in the brick division, into the separate bottom flues, D D, running beneath the whole bottom of the boiler, and finally joining in the main flue at E. By this arrangement, the most intense heat is confined to those parts of the boiler where sediment is least likely to be deposited, that is, on the top of the internal flues; and this part being nearest the surface of the water, the steam evolved is more easily carried off in a dry state. To retain the front brick-work above the fire doors, a stout cast-iron beam, F, is passed across the boiler end, each end of the beam being embedded in the boiler and engine-house walls, that in the former being further secured by a tie-rod bolted to a washer sunk in the wall.

The state of the water-level in the boiler may be observed either by the glass guage, G, or the index of the stone float, H; or it may be tested by the set of guage cocks attached to the glass guage. The index of the stone float is attached to the counterweight, I, which works freely inside a cast-iron pillar frame, slotted down the front for the passage of the index, and graduated in inches. Immediately before this pillar is placed an alarm-whistle, which is rendered self-acting, in case of want of water, by connection with the counterweight of the stone float.

The steam is taken from the boiler by an open-ended T-headed pipe, K, which is cottered to a bolt stud, passing through the top of the receiving dome. The lower end of this pipe has an elbow for bolting to a short elbow pipe, L, the end of which is bored to receive the foot of the stop-valve chest, M. The flange of the latter rests on the top of the boiler, and bolts pass through it to the flange of the pipe, L, the socket of which is thus held up against the conical foot of the stop-valve chest. N, Is the main safety valve, fitted on a branch of the cross steam pipe connecting the valve chest, L, with the main stop-valve elbow, O. A second safety valve, P, is also fitted to a branch at the stop-valve chest; this valve is loaded to 5 lbs. per square inch more than the main-valve, and is intended to act only in case of the latter getting out of order. The bearing faces of this second valve are flat, instead of conical as usual, and has consequently much less tendency to stick to its seat.

The stop-valve for regulating the steam supply of the engine, is worked by a hand-wheel, Q, on a shaft passing through the wall of the engine-house. This shaft carries a small bevel wheel, gearing with a similar wheel, whose boss acts as a nut for the screwed spindle, R, of the stop-valve, which is guided in its vertical movement by a cross piece working between the side rods, S S. The hand-wheel, Q, being placed in the engine-house, directly opposite the starting gear of the engine, the engine-man has perfect command over it, without moving far from his post. Should any accident occur to the engine whilst he is in the boiler-house, he can also easily shut off the steam without going round to the engine-house for the purpose.

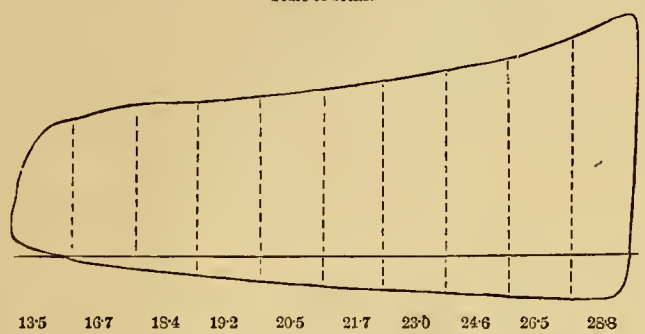
A double-valve chest is also fitted at T, for the two purposes of regu-

lating the feed of water, aud blowing off. The feed-water is supplied hy a pump worked from the side lever of the engine, the water heing conveyed hy the pipe, u, to the valve-chest, t, whence it passes into the boiler; the surplus water, when the valve in this chest is closed, heing discharged hy a hranch pipe, v, fitted with a lever-valve, weighted a little ahove the steam pressure. The second valve in the chest, t, is for hlowing off the dirty water which may collect in the hottom of the hoiler. The working pressure of this hoiler is 35 lhs., and the exact pressure may he at any time ohserved upon a mercurial guage fitted up in the engine-house.

We give helow, a diagram taken from each cylinder, from which our readers will be able to draw their own deductions.

High-Pressure Cylinder, 22 inches diameter, 4 feet stroke.

Scale of 20ths.

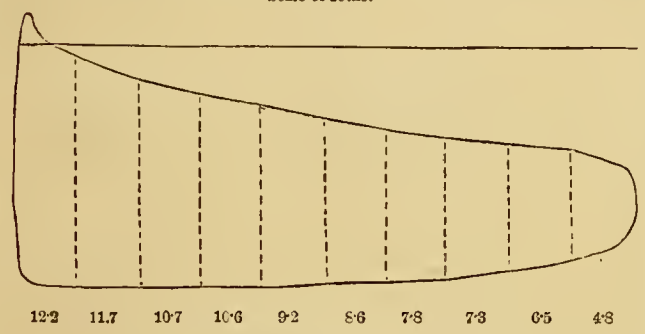


13·5 16·7 18·4 19·2 20·5 21·7 23·0 24·6 26·5 28·8

Average Pressure, 26·29

Low-Pressure Cylinder, 33 inches diameter, 4 feet stroke.

Scale of 10ths.



12·2 11.7 10·7 10·6 9·2 8·6 7·8 7·3 6·5 4·8

Average, 8·88.

These figures are sufficiently explanatory of the action of the engine, and they teach us that the lahouring force of the two cyliuders is equal to 130 horse power, including friction, or, deducting this, to 113 horse power. We have not yet tested the consumption of fuel, for the reason that the boiler arrangements are not yet completed—whatever it may now he, its amount will bo considerahly lessened when the hoiler and steam pipes are felted.

One great point in the safety of this boiler, is the non-liability of a collection of sediment on those parts of the metal where the most intense heat is applied. A want of attention to this point has caused the destructive burning and explosion of numherless hoilers, in spite of every precaution of the engine-man. In another case in this city, where six of this class of boilers replaced three of the large mariue kind, the consumption of fuel was lessened to the extent of 2½ tons per day, tho speed of working heing also increased.

RUSSIAN STEAM FRIGATE "VLADIMIR."

Some time ago, Mr. Mare, the eminent ship-huilder of Blackwall, and Messrs. Rennie, the marine engineers, were commissioned hy the Emperor of Russia to huild and engine-fit him a steam frigate, to answer also as a private yacht for the emperor's own use. The vessel has just heen completed, and, after several trial trips, has run down to Plymouth to take in stores, and prepare for her voyage to Sehastopol, in the Black Sea. She is huilt throughout of oak, and her engines, as kindly detailed to us hy Messrs. Renuie, present a numher of novelties. Her engines are horizontal oscillators; cylinders 73½ inches diameter, with a six feet stroke. Each cylinder has two slide valves, which act as equipoises to each other. They are worked from the crank-shaft by a modification of the link-motion, as applied to locomotive engines; backward and forward eccentrics heing employed for giving corresponding movements to the vessel, iu the same manner as in the oscillating engines fitted up in a boat on the Danuhe, by Mr. Joseph Hall, described and illustrated in our June number. The air-pumps are placed hetween the cylinders, fore and aft, on each side of the paddle-shaft, from a central crank, on which they are worked hy vihrating trunks containing the connecting-rods for the huckets. The condensers and air-pump cases are cast in one piece. The fixed and hilge pumps are worked by studs on the oscillating cylinders.

The entahlature carrying the crank-shaft is composed of ½ and ⅝ inch hoiler-plate riveted together, and is supported on wrought-iron columns keyed into the hase of the condenser. The crank-shaft is of wrought-iron, 18 inches diameter, all in one length. It is carried on four long bearings; two on the entahlature, and two on wrought-iron brackets, projecting from the sides of the vessel, thus leaving the shaft totally independent of the paddle-hox heams. The paddle-wheels are 25 feet in diameter, and 9 feet wide; they may be disconnected at pleasure by friction discs ou the paddle-shaft. The expansion, hlowing-out, steaming, starting, and injection gear, with the steam guages and harometers, are all placed together, so as to be within convenient reach of the engine-man. The steering-wheel is near the funnels, of which there are two; the steering chains heing conveyed from the paddle-hox hridge hy channels and guides, as in several boats on the Clyde. The communication between this bridge and the engine-room is kept up hy a telegraph, so that the signals for the various movements are conveyed to the engine-man without the confusion resulting from the employment of call-boys, and indistinct motions of the captain's hand.

The hoilers are tubular, four in numher, and placed with their backs to the engines. The up-takes of the hoilers are fork-shaped, so as to admit of a free passage through helow the funnel, from the captain's and officer's cabins to the engine-room, thus avoiding the necessity of going up on deck, and then down into the engine-room again.

The average speed of the ship at the measured knot in Long Reach, was 11 knots per hour, the paddles making 18½ to 19 revolutions, their effective diameter heing 24·5 feet. Mean draught, with guns and stores on hoard, 14 feet 6 inches. Indicator giving a mean pressure of 20 lhs.; vacuum, 26½ inches of mercury. The dimensions of the engine-room are 60 × 27 feet; weight of engines, 220 tons.

Messrs. Rennic have also just completed a second vessel for the same service. She is named the "Elhroz," and is of 600 tons burthen. She was huilt hy Messrs. Wigram of Blackwall. Her engines are 260 horse power, and are of a construction similar to those of the "Vladimir." A recent trial gave her speed as 11 knots, in the average of five runs. She is destined to carry troops, and has all the necessary fittings for such service. Amongst other novelties, she carries traversing guns, on the principle of Colonel Colquhoun.

We understand the "Vladimir" performed the trip from the Nore to the Isle of Wight, 154 miles, in thirteen hours.

THE DYNAMICAL DEFLECTION AND STRAIN OF RAILWAY GIRDERS.

Under the title of "Notes on Engineering," by Homersham Cox, B.A., an article appears in the *Civil Engineer and Architect's Journal*, for last month, on railway girders. We there learn that no suhject in practical science has heen more elahorately investigated, than the theory of the statical transverse strength of beams, and that mathematicians and experimentalists have co-operated in the research, and the result of their united lahours has heen a valuahle and comprehensive system of knowledge.

This is good and satisfactory evidenco so far as it goes; hut we are further instructed that great discrepancy of opinion still exists amongst engineers, as to whether the effect of a moving load on a railway, is greater or less than when at rest, that the necessity of further inquiry is generally acknowledged; some engineers having *imagined* it may become a source of safety, hy causing the railway train to pass over hefore the girder has had time to yield, and others have *estimated* the effect of a moving load, as highly as six or seven times that of the same load at rest!!!

This discrepancy of opinion, it appears, has caused the Commissioners of Railways to recommend a Government commission to he appointed, for the purpose of inquiry, so that the paper of Mr. Cox (in his own words) may he taken as "a contrihution to a more accurate knowledge of this important question, which has at length attracted the attention due to its influeuce on the security of railway traffic."

It will presently be seen what additional security is derivable from the theories which Mr. Cox propounds, but it is due to him in candour to warn the railway traveller, that no pains have been spared by him to render his views correct; they have occupied many months of reflection, and have been subjected to the careful revision of his mathematical friends.

I am free to say, after a careful examination of the eleven columns of the Journal, which Mr. Cox's paper occupies, that he has not hit the nail on the head; and if the adage be true, that too many cooks spoil the broth, he may with reason exclaim, "Oh! that I had been spared the aid and assistance of my *mathematical* friends." Instead of adding an observation on the merit or otherwise of Mr. Cox's paper, I propose to set out in plain terms the purport of the investigation, of which he must entirely have lost sight; nor is this extraordinary, when his concluding sentence is,—"As the great object has been to exclude all operose mathematical investigations, it will readily be understood that the subject, by constant corrections and simplifications, has assumed an entirely different shape to that originally given to it."

The great object of the subject intended for investigation, I submit, is shaped as follows:—When a railway train is in motion over a bridge, is its tendency to deflect the girders of the bridge more or less than when the same train is at rest thereon?

We have not far to travel for an answer to this posing question, for the paper of Mr. Cox supplies the following intelligence. On the Dee bridge, "an engine and train of 48 tons at rest, gave a deflection of 2·4 inches; while the deflection caused by the same train, at a speed of from 15 to 20 miles an hour, was only $1\frac{5}{8}$ inch.

Mr. Cox quotes another experiment on the same bridge. An engine and tender, of about 30 tons weight, passed over the bridge at 15 miles an hour, and produced a deflection nearly the same as with the engine at rest, viz. from $\frac{7}{8}$ to $1\frac{1}{16}$ inch. Whence it is to be noted, that the deflection caused by the engine and train in motion, was nearly equal to that caused by the engine only at rest; whence the inference from the two experiments is, that a train moving on a railway bridge, causes less deflection of the girders than when at rest; and further, that as the deflection is less in the former case, so also is the pressure or stress which causes it.

We further learn from Mr. Cox's paper, that these are the only experiments that have been made, and that they do not furnish much information suited to his purpose. Decidedly they do not; but the very contrary fact he attempts to establish in theory, is thereby cancelled and disproved.

These two experiments, be it said, are described in a report to the Commissioners of Railways, of June 15, 1847, fourteen days after which they published a minute, recommending a commission of inquiry into the matter; but as fifteen months have elapsed, and no other experiment has been made during that time, the inquiry seems to have been treated as disrespectfully as if the commission were a mere job.

It would have been well had the names of the engineers transpired, who *estimated* the effect of a moving load at six or seven times that of the same at rest, for the estimate would have been a curiosity, deserving to be embalmed or pickled for the benefit of futurity.

15, *Goulden Terrace, Islington,* JOHN CURR.
October 7, 1848.

IMPROVED HYDRANT, OR FIRE-COCK.

By Mr. M. Scott, C. E., Liverpool Water Works.

Illustrated by Plate 19.

The present widely-spread movement in favour of sanatory reform has had the effect of quickening the ideas of our mechanical inventors, and, amongst the rest, hydraulic mechanism has received a considerable impetus. A plentiful supply of pure water must ever be the grand feature in cleansing operations, for without it all other means are totally ineffectual. Nor is the mere power of supply the only point to be looked to, for we have had too much experience in the difficulties attending its obtainment, when urgently wanted, to forget the inconveniences often occasioned in this way. We have had hosts of stand-pipes, fire-cocks, and cisterns, with their attendant myriads of hydraulic appendages, many of them by far too ingenious for every-day work, and others too expensive and unmanageable. But the disease works its own cure, and what experience finds wanting, after-thoughts must supply.

Mr. Scott, of the Liverpool Corporation Water Works, has favoured us with a specimen of a hydrant of his invention, which appears to remove the bulk of the objections met with in the existing fittings of a similar class.

Fig. 3, in plate 19, is a vertical section of the hydrant in its complete state, one-sixth the actual size. A, Is the branch elbow-pipe from the main, to which the cast-iron shell of the hydrant, n n, is bolted by four bolts. This shell has an internal projecting rim or flange near the top, which is bored to receive the hollow brass plug, C, through which the water finds its exit from the main. A double-threaded screw, D, one inch pitch, is cut on a projecting spindle, cast in a piece with the lower end of the plug, C; and this screw works through a brass cross-piece, E, checked into the bottom of the outer shell, B, to act as a nut for the vertical movement of the plug in opening and closing the hydrant.

The water from the main always keeps the space between the exterior of the plug and the interior of the shell, B, full, as far up as the bored internal flange of the latter; and when the plug is screwed downwards to its lowest position, as in our plate, it escapes into the interior of the plug by the line of slots, F, and thence up the barrel to the hose or stand-pipe. The stuffing-box of the plug, being intended to stand an excessive pressure, possesses several peculiarities. The gland is cast finished, of composition metal, in which tin forms the chief ingredient; the cupped portion at the bottom of its ring, which fits to the plug, slightly overlaps a gutta percha ring, with a bottom flange; and in the groove formed by this flange and the bottom edge of the gland, a narrow packing ring of hemp is placed as stuffing, the adjustment being effected by screwing down the three bolts of the gland in the usual manner.

The interior of the top of the plug is grooved on each side for the reception of two feathers on the coupling for attaching the hose; and the upper screw on this coupling is left-handed, so that, when the hose is attached, the plug of the hydrant may be turned to depress it, in obtaining a supply of water, without endangering a twisting of the hose.

As regards the facility afforded for repair, this hydrant presents very superior advantages, for it is only necessary to unscrew the four bolts which attach the shell to the main, when the whole may be lifted out and carried to the workshop, another being put down in its place—the whole operation occupying only a few minutes, and leaving the pavement of the street uninjured. The working surfaces are peculiarly well adapted for durability, and any slight wear which may take place cannot affect the tightness of any part; and the internal pressure of the water in the mains tends only to close the plug by its action upon the screw. Provision is also made for avoiding the inconveniences of frost, as no water remains inside the tubular plug when closed, and as the orifices are passed a short distance above the packing ring, the water in the tube always flows out.

The opening screw is made of considerable pitch, one turn being sufficient to elevate or depress the plug one inch, and the gradual action of the screw prevents the occurrence of any sudden shock from the rush of water. No "stand-pipe" is required in connection with the hydrant, the communication with the hose being entirely effected by a short brass tube screwed at each end. For opening and closing, nothing more is required than one of the small lever keys used by the fire police for coupling lengths of hose, so that no delay can occur from a want of the proper keys; but should no fireman be present, an opening may be generally effected with a walking-stick, or a cord attached to the horns of the coupling.

In point of cheapness, which is a great point in municipal calculations, we are informed that hydrants, 2-inch bore, may be made for something less than £1.

ON THE COHESIVE POWER OF CEMENTS AND MORTAR.

The qualities of cements afford abundant food for discussion amongst engineers, and we rarely hear of two authorities who concur in their opinions on the subject. With the view of putting an end to existing doubts, experimental tests have been resorted to by the various manufacturers and builders. Although such trials are not to be considered as conclusive, they yet lead us to form a tolerably accurate idea of the relative practical value of the rival materials. At page 106, *ante*, we gave the results of Messrs. Grissell's trials of Messrs. White's cement; we now present a similar series, undertaken by Messrs. Robins and Aspdin, of the Northfleet Works. The mode of test was that of a pier of bricks, projected from a wall, and attached by cement only, face to face, having stood 27 days on supports.

1. Neat cement, 14 bricks; third brick gave way with 9 cwt. on seventh.

2. 1 cement, 1 sand, 30 bricks, 8 lb. on each brick; gave way with 7 lb. added.

3. 1 cement, 2 sand, 22 bricks; broke in cement and bricks, with $3\frac{1}{2}$ cwt.

4. 1 cement, 4 sand, 25 bricks; broke in bricks with $\frac{1}{2}$ cwt. on last brick.

5. Neat cement, 38 bricks; broke with weight on 38th, equal to 40 bricks.

6. 1 cement, 5 sand, 26 bricks, weight added equal to 30 bricks; stood a quarter of an hour, when additional weight, equal to 35 bricks,

was added; weights taken off, ½ cwt. put on 26th brick; sustained until a brick broke under 74 lbs.

7. 1 cement, 1 sand; stood 28 days; 15 bricks, supported at each end; bearings 2 feet 6 inches apart; broke with 15 cwt. suspended from centre. The bricks in these trials were the better quality of stocks. Another set of trials took place with brick beams of 5 feet span; bricks laid horizontally, three in breadth, and three in thickness, with supports at each end; built on sand, and about two lengths of brick in thickness, from outer edge to inner span. Stood about a month.

1. Neat cement; loaded by degrees with 2 tons 18 cwt., in cwts., when the bricks broke across in two places.

2. 1 cement, 5 sand; broke in brick and yielded in cement in the middle, under 31 cwt.

3. 1 Roman cement, 1 sand; broke in brick and yielded in cement in three places, under 29 cwt.

4. 1 cement, 3 sand; split partially in two places, under 47 cwt.

5 1 Roman cement, 2 sand; broke with 21 cwt. The bricks in these cases were inferior in quality, and were considered to have a feeble power of adhesion to the cement.

Two blocks of Portland stone, 2 feet by 9 inches, area joined by Portland cement, set for 28 days, were slung on a bearing 3 feet 6 inches across, between two pairs of dogs or nippers, with a weight of 38 cwt. At this weight the upper stone scaled and broke; the lower one carrying away a film of it, with the cement almost entire. Hydrostatic pressure was then applied vertically to a series of blocks, 18 inches long, 9½ inches broad, and 9 inches thick.

1. 1 cement, 4 sand; began to scale under 25 tons, and split up and down into three wedge-formed pieces, with 45 tons.

2. Neat cement; scaled slightly under 58¼ tons; press not sufficiently powerful.

3. Neat Roman cement, not well squared; broke with 22½ tons.

4. 1 cement, 5 sand; crushed with 9 tons.

5. 1 cement, 6 sand; split with the sudden application of 13½ tons.

6. 1 cement, 7 sand; weight increased from 18 to 25 tons, when block yielded.

7. 1 cement, 3 sand; split with 14 tons.

8. 1 cement, 1 sand; stood all the power of the press, 45 tons.

A piece of neat cement 1½ inch surface by 1 inch, six months old, laid on its inch surface, was partially crushed with 18 tons. A similar piece of Portland stone is stated to have gone down under 23 cwt. In all these trials, it was evident that the blocks did not always bear fair one against the other, and so far their arrangement was disadvantageous for the cement.

On a subsequent experiment, with a more powerful hydrostatic press, being made at the Pimlico establishment of Messrs. Robinson:—

1. One of the neat cement blocks, mentioned above, 35 days old, bore 68 tons, when it cracked at one angle, but ultimately bore 98 tons without a change.

2. A similar block bore 141 tons without a crack, but finally broke when standing under it.

3. Another of the same quality bore 104 tons.

4. One of 1 cement, 9 sand, bore 4½ tons.

5. One of equal parts of cement and sand, previously tried up to 47 tons, now cracked at that pressure, but finally bore 108 tons.

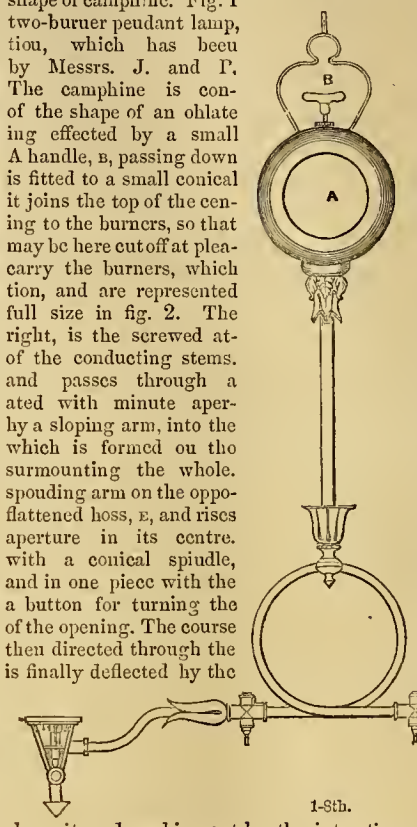
Whilst upon the subject, we add a table of experiments on mortar, made by Mr. Baylis of Chester, for which we are indebted to *The Builder*. The area of bed-joint was 4½ inches square.

Materials.	Proportions.	Breaking Weight in lbs.
Common lime and sand	2½ to 1	Broke at 160 lbs.
Ditto ditto	2 „ 1	Do. by accident.
Ditto ditto	1½ „ 1	Do. at 100 lbs.
Ditto ditto	1 „ 1	Do. by accident.
Ground lime and sand	2½ „ 1	Do. at 95 lbs.
Ditto ditto	2 „ 1	Do. at 140 lbs.
Ditto ditto	1½ „ 1	Do. at 235 lbs.
Ditto ditto	1 „ 1	Do. at 215 lbs.
Common lime and fine hammer scale	2½ „ 1	Do. at 90 lbs.
Ditto ditto ditto	2 „ 1	Do. at 100 lbs.
Ditto ditto ditto	1½ „ 1	Do. at 90 lbs.
Ditto ditto ditto	1 „ 1	Do. at 65 lbs.
Ground lime and coarse hammer scale	2½ „ 1	Do. at 270 lbs.
Ditto ditto ditto	2 „ 1	Do. at 280 lbs.
Ditto ditto ditto	1½ „ 1	Do. at 275 lbs.
Ditto ditto ditto	1 „ 1	Do. at 260 lbs.
Common lime and coarse hammer scale	2½ „ 1	Do. at 140 lbs.
Ditto ditto ditto	2 „ 1	Do. at 80 lbs.
Ditto ditto ditto	1½ „ 1	Do. by accident.
Ditto ditto ditto	1 „ 1	Do. at 130 lbs.
Ground lime and fine hammer sand	2½ „ 1	Do. at 265 lbs.
Ditto ditto ditto	2 „ 1	Do. at 230 lbs.
Ditto ditto ditto	1½ „ 1	Do. at 265 lbs.
Ditto ditto ditto	1 „ 1	Do. at 265 lbs.

HOLLIDAY'S SELF-GENERATING GAS LAMP.

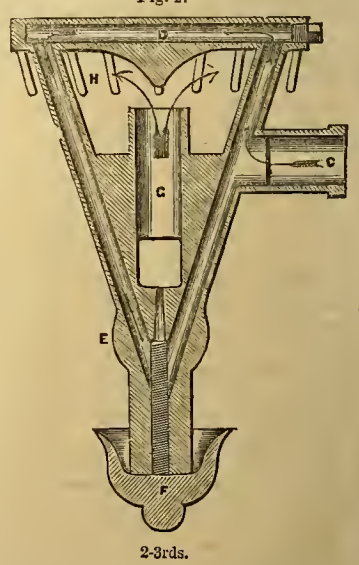
This is a most ingenious contrivance, whereby the ordinary camphine is manufactured into a brilliant gas, in the operation of burning, without any wick or draught glass. Unlike all oil or spirit lamps, Mr. Holliday's invention requires no trimming, or any adjustment further than the mere supply of combustible matter in the shape of camphine. Fig. 1 is a view of a complete two-burner pendant lamp, of very simple construction, which has been obligingly supplied to us by Messrs. J. and P. Stewart, of this city. The camphine is contained in the reservoir, A, of the shape of an oblate spheroid; the supply being effected by a small screw stopper on the top. A handle, B, passing down the centre of the vessel, is fitted to a small conical valve in the bottom, where it joins the top of the central columnar tube leading to the burners, so that the flow from the reservoir may be here cut off at pleasure. Two curved stems carry the burners, which are of peculiar construction, and are represented full size in fig. 2. The right, is the screwed at- tion, and are represented on a scale of two-thirds full size in fig. 2. The short branch, C, on the right, is the screwed attaching branch for the end of the conducting stems. The camphine enters here, and passes through a thin diaphragm, perforated with minute apertures, and thence upwards hy a sloping arm, into the top horizontal passage, D, which is formed on the surface of a circular disc, surmounting the whole. Descending by a corresponding arm on the opposite side, it reaches a flattened boss, E, and rises through a small conical aperture in its centre. This aperture is fitted with a conical spindle, screwed at its lower end, and in one piece with the cup, F, which answers as a button for turning the spindle to adjust the size of the opening. The course of the gaseous matter is then directed through the central chimney, G, and is finally deflected by the inverted cone immediately above it, and, rushing out by the interstices of a circular ring of pins, H, it is ignited, and burns in the form of a ring of eight, ten, or more jets. The burner is of brass, and, with the exception of the cup, F, at the bottom, is cast in one piece. By unscrewing the cup, a wire may be introduced for the purpose of removing any obstruction in the two side tubes, and the screwed plug on the right of the upper passage provides for a similar remedy at the top.

Fig. 1.



1-8th.

Fig. 2.



2-3rds.

In lighting the lamp, a few drops of pyroxilic, or wood spirit, are poured into the cup, F, and ignited; the heat thus produced, volatilizes the camphine in the various passages of the burner, and the heat resulting from the combustion of the gaseous product, then serves to keep up a continuous stream of the gas. The supply of the liquid may be also still further adjusted by stop-cocks in the branches.

Its simplicity of construction renders this a very cheap lamp, and we observe it can be constructed for as low a sum as 10s. The light is most brilliant, and is stated to be very tenacious, so as to render it valuable for rough service, where side draughts are met with. In the one which we saw burning, no smoke was perceptible, and the smell of the liquid was very slight. Its principle is, of course, capable of adaptation to all shapes of lamps.

WALMSLEY'S AUTOMATIC SAFETY VALVE.

Illustrated by Plate 19.

The late serions steam-boiler explosions appear to have aroused public attention, and, as a natural result, we now find professioual men making efforts to allay the anxiety thus occasioned hy introducing additional safeguards. Mr. Edward Walmsley, of Bankfield Mills, near Stockport, has, amongst others, paid considerable attention to the safety qnestion, and we have great pleasure in making known his self-acting arrangement for carrying off any surplus pressure.

Figure 4 of Plate 19, is a sectional elevation of a steam-boiler, with the improved safety valve applied to it. The steam-escape valve is represented at A, with its weighted lever prolonged on the opposite side of the fulcrum. To the extremity of this prolongation is hung a small bucket, B, fitted with a discharging tail valve; C, is the feed or register pipe of the boiler, constructed in the ordinary manner, and communicating by a short cross pipe near its upper end, with a second vertical pipe, D, the lower end of which stands immediately over the bucket, B, when the safety valve is shut down. The cross pipe connecting the main feed-pipe, C, with the pipe, D, is placed at such a height, that upon the occurrence of the least over-pressure, the water in the boiler will ponr ont from it into the bucket, B, the increased weight of which then draws down the end of the lever to which it is attached, and opens the valve for the free escape of the steam. The same movement of the valve lever also opens the cold air damper, E, thus admitting a current of cold air over the grate bars, and along the internal flue of the boiler, to check the further rising of the steam, and to preveut all chance of burning the boiler bottom.

The contrivance is applicable to any of the ordinary so-called safety valves, which may thus be rendered most certain in their action, as the opening force is entirely independent of the mere steam pressure acting on the valve itself. The moment the internal pressure raises the water colnmn to the level of the discharge pipe, the water poured out acts as an overwhelming counterpoise against the loaded end of the valve lever, and throws the valve open to its full extent.

Any one who has attentively observed the action of an ordinary weigbted valve, upon an nndne increase of steam pressure, must have been struck with the inefficient means provided for the escape of the surplus vaponr. Even when the surfaces do not stick, which is too often the case, an inordinate increase of pressure seldom acts further than to cause the least possible elevation of the valve, permitting as much steam to pass as will attract the notice of the engine-man, if he is at hand, and no more. Such an oozing out of pressure, has, of course, little effect in restoring matters to their proper condition—hence the dangerous accumulation of explosive power.

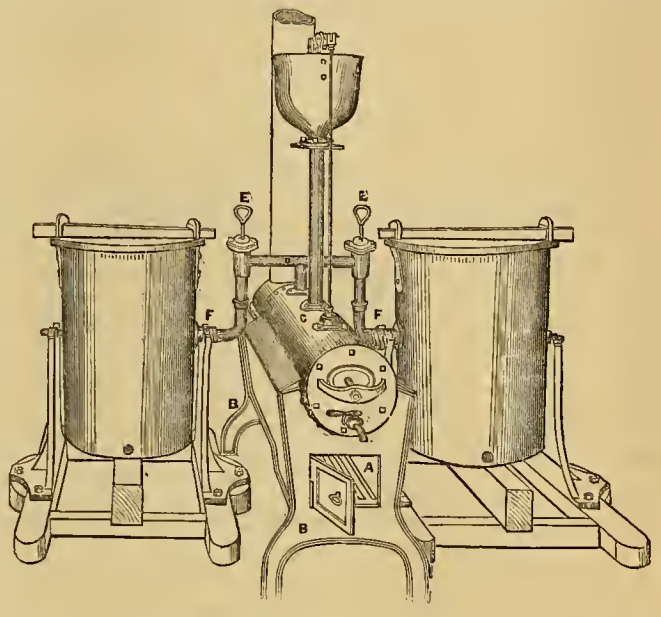
There is another objectionable point connected with the plain conical-seated valve, which has been often touched upon by theorists, whilst nothing practical has been done for its removal. This is the increased area opposed to the pressure of the effluent steam, when the valve is raised in the least from its seat. For example, the actual opening in a boiler, below the valve, may he 12 inches in area, and of course the valve surface opposed to the steam pressure is of the same size, as long as the valve is closed. But when, by a slow accumulation of pressure, the valve rises a hair-breadth from its seat, the feebly escaping vapour then acts npon an amonnt of valve surface, increased by the horizontal breadth of the cone, and the action of the weighted lever or spring is now opposed by a virtually greater area of valve. Thus it happens, that when the valve is once raised, steam will escape by it long after the diminution of the pressure below the true working point.

By introducing an independent external opening force, Mr. Walmsley obviates this, as well as the more serious chance of sticking. The addition of a quantity of water to the long leverage opposing the dead weight on the valve, gives a free passage for the steam; and when the actuating discharge of water ceases, the tail valve in the lever bucket, or a small dribbling apertnre, permits of the speedy removal of the equipoising weight, and the dead weigbt again comes into play with power sufficient to shut down the valve. The water which has been supplied to the bucket falls into a small receiver below, whence it may be conveyed away by a conducting pipe passing down the boiler side.

In the original trials of this arrangement, a practical difficulty occurred, in the shape of a long-continued current of water through the main feed-pipe, C, after the pressnre had subsided, producing by another way the objection, redaction of the pressure, to which we have before adverted. This current has been efficiently checked by making the connection pipe for the pipe, D, of small bore, so as to set in motion a very small colnmn of water; and by placing the lower end of the feed-pipe, C, in the most undisturbed portion of the water in the boiler, all fluctuation is removed.

PORTABLE APPARATUS FOR STEAMING FOOD FOR CATTLE.

This is one of those refinements which the spread of agricultural mechanics has latterly introduced into the farm-yard, to the intent of reducing the manufacture of food to a defined philosophical system. It is the production of Messrs. Sandford and Owen, of the Phœnix Works, Rotherham, to which firm the farming interest have been indebted for numerous improvements. A, Is the furnace of the apparatus, which is enclosed



between two cast-iron side plates, attached at their ends to the back and front standards, B B. The upper ends of these standards are cut away to receive the cylindrical boiler, C, which rests upon them, the spaces between its sides and the upper edges of the side plates being filled up by separate plates at the top. The boiler is fully equipped with a feed-cistern, stone-float, and valve; its steam is taken off by a central pipe, D, cast with two angular branches, E E, fitted with stop-valves. Two short elbows connect these branches with the vegetable pans or steamers, F, by means of stuffing-boxes, carried by the two inner standards on which the pans are hung—the outer or opposite sides of the pans being merely suspended on stud pins.

This method of attaching the pans admits of easy management in emptying. The pan-covers are simply discs of timber laid on, and held firmly down by two long stout wooden wedges passing through staples attached to the upper edges of the pans. A few blows on the smaller ends of the wedges forces them out of their staples, when the lids may be removed, and the pans swung round to discharge their contents.

The boiler and appurtenances is complete in itself, supported on its end standards; and each pan rests upon a separate substantial timber framework as a base.

THE MECHANIC'S LIBRARY.

Architecture, History of Ecclesiastical, 8vo. 12s. cloth. G. A. Poole.
Architecture, History of, royal 8vo. 24s. cloth. Mrs. Tuthill.
Chemistry, Introduction to Practical, foolscap 8vo. 6s. 6d. cloth. J. E. Bowman.
Chemistry no Mystery, second edition, foolscap 8vo. 5s. cloth. Dr. Scoffern.
Chemistry, School, foolscap 8vo. 7s. cloth. R. D. Thomson.
Engineer's and Mechanic's Cyclopedia, 2 vols. 30s. Luke Hebert.
Harbours of Refuge on S. E. Coast of England, 2s. 6d. E. Portwine.
Industry, Essay on British, foolscap 8vo. 2s. 6d. cloth. W. Burness.
Trees, On their Uses and Biography, 18mo. 3s. cloth. J. Sheppard.

RECENT PATENT.

M'CONOCHIE AND CLAUDE'S LOCOMOTIVE, WITH INSIDE WHEELS AND OUTSIDE FEED-PUMPS AND VALVE-GEARING.

The firm by whom these improvements have been brought forward is one of modern establishment in Liverpool, possessing considerable inventive energy.

In the patent now under uotice, the locomotive has undergonc a thorough revision in all its chief details, and we find in it several clever arrangements. The cylinders are enlarged to a great extent, without addiug to the width of the engine. They are placed side by side in contact, and immediately behind the leading wheels, the whole of thc valve-gearing being on the outside, and worked by eccentrics carried by the naves of the driving wheels, pins on which work the feed pumps. An effective double-beat safety valve is introduced, wherehy a large area for the escape of the steam is obtained without the disadvantages of the powerful springs which would be required for the ordinary valves, and a very short rise gives free vent for the steam. Within certain limits this species of valve may be judiciously employed; but it is to he remembered, that the further the principle of balanced pressure is carried out, the more chances of sticking occur.

A modification of a cut-off of slide valves is also shown; and here the patentees appear to have acted most unadvisedly, for nearly the same thing has heen inventcd and patented hy at least three parties previously. In order to bring the harrel of the boiler to a lower level, a pecnliar contrivance is adopted, wherein the driving cranks are formed, as it were, half on the axle and half in the driving wheels, and the scheme is certainly novel. The axle or driving shaft has a very gradual bend formed on it at each cnd, just where it enters the wheel. These bends being at right angles to each other, and of a length eqnal to the required crauk, each answer as a side arm; and the axle being continued straight on from the termination of the bend, in a line with the main axis, is keyed into the boss of the wheel, whilst the return arm is formed by the wheel itself, a short shaft being keyed in the true centre of the nave to act as the external axial bearing. By this arrangement, the patentces are enabled to get the centre lines of their cylinders further apart, by all the thickness which would otherwise be taken up by the two outside arms of the crank, and the boiler is lowered proportionahly. Another useful idea is that of adjusting the weight on the wheels of the engine whilst running. A toggle joint is placed intermediate hetween the bearings of the axles of the trailing wheels and the springs of the carriage (which are immediately over them), and connected by joints to the engine frame and springs. A rod connects the knuckle of this toggle joint to the piston rod of a small steam cylinder, which is connected with the boiler by means of a pipe, upon which there is a stop-cock. When the driver wants to increase the weight borne by the driving wheels, he has only to open thc stop-cock, which will allow either steam or water from the boiler to enter above the piston, and this will, of nccessity, draw the toggle joint into an upright position, and so cause the weight of the locomotive to come more upon the driving wheels, and to reduce, in a corresponding degree, the weight upon the trailing wheels. And to produce the opposite effect, the driver has hut to allow tho steam or water to escape from above the piston, and go into the reverse end of the cylinder.

Amongst the rest of the heads of thc inventions, is an arrangement for a self-acting steam-hreak. A series of tubes lead from the steam boiler underneath thc tender and carriages, and are iuterlocked with one another, in manner to be afterwards explained. The engineer has at his command a cock, by which he can in an instant admit steam into these tubes, or shut it off. The steam, when so admitted, may he madc to actuate, in various ways, breaks placed hetween the wheels. For example, it may he conveyed by a branch pipe into a small vertical working cylinder, and made there to press a piston upwards, so as to throw out two breaks (connected with the piston), one against the front wheel and tbe other against the hind wheel; or it may be made to act directly upon thc breaks themselves; or it may be made to act on a weighted lever break, through the medium either of a horizontal cylinder or of a vertical one. Each length of tubing is made of a receiving form at one end, and of an entering form at the other. The former is widened considerably at the mouth; and just at the point where it begins to be widened, an annular spring, made of vulcanized caoutchonc, is inserted in a scat made for it on thc inside of the tube, and made fast thercto. Before thc entering tuhe is inserted, the face of the annular spring projects slightly heyond the inner periphery of the receiving tube; but, on that tube being pushed in, it presses back the annular spring, which afterwards closes tightly upon the entering tube, and forms a perfectly steam-tight joining. The different lengths of tubes are thus joined together by simply thrusting the one into the other; an operation which takes up but little time, and requires no skill whatever. And when the driver sees occasion to stop or check the progress of a train, he can instantly, without losing time, or communicating with any one, let on the steam, and bring all the hreaks of a train into simultaneous operation.

A simple method is also shown for detaching the coupling hooks of a train, without thc incouvenieuce of slacking hack, to get the entrauces of the hooks off their links. The improvement is adapted to the right and left screw coupling of Mr. Booth, aud consists in the application of a couple of detaching eccentrics, one to each chain. Each screwed spindle has forged upon it an eccentric hoop, the eccentrics of which are locked in their tightened position by suitahle stop pins. In detaching, the fixing pin being removed, a lever on the stud-shaft of the eccentrics admits of the latter being turned half round, when the coupling will be expanded sufficiently to allow of its detachment from the hooks.

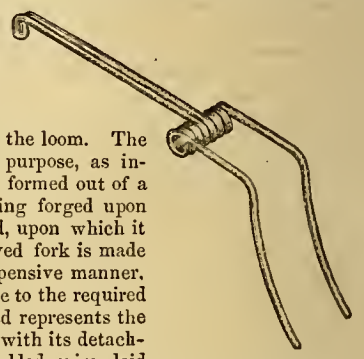
Patent dated March 8th, 1848. *Specification enrolled September 8th*, 1848.

REGISTERED DESIGN.

FORK FOR WEFT PROTECTOR.

Registered for Mr. D. Walsh, *Little Govan, Glasgow, October 5th*, 1848. *No.* 1609.

Amongst the latest additions to the power-loom, is an ingeniously simple plan for stopping the motion of the machine when tbe weft thread breaks. This is accomplished by a short bent metal lever, termed a "fork," balanced on a stud carried by the lay of the loom. The bent end of the lever is formed into three prongs, against which the weft thread presses in its passage across the warp threads. Each time the shuttle is thrown, the pressure of the thread on the prongs of the lever raises the contrary end of the latter; but should the thread break, thc absence of its pressure permits the lever to remain unlifted, and a short hook upon its opposite end, acts upon the connections of the stop-motion, so as to throw the driving strap upon the loose pulley, and stop the loom. The forks hitherto in use for this purpose, as invented by Mr. Kenworthy, are formed out of a solid piece of metal, an eye being forged upon it for the reception of the stud, upon which it oscillates. Mr. Walsh's improved fork is made in a much simpler and less expensive manner, by bending a single piece of wire to the required shape. Thc engraving annexed represents the wire fork; the straight portion with its detaching catch being formed of douhled wire, laid parallel, whilst the central eye is produced by coils of the same, the two ends bent downward answering as prongs.



This fork is mannfactured at a much less cost, both of time and material, than the solid metal one, as the whole operation is confined to the bending of the wire, and touching the coils with solder if deemed necessary as a binder.

The parts in this design, which are novel and original in shape and configuration, are the whole of the parts as formed of wire, in the manner before mentioned.

REVIEWS OF NEW BOOKS.

Introduction to the Study of Natural Philosophy, for the use of Beginners. By Charles Tomlinson. London: Weale. 1848. Pp. 162. Woodcuts.

With each recurrent month, we find something of note emanating from Mr. Weale's stores of literature, and we have now the pleasure of presenting to the notice of our readers thc second volume of his "Series of Rudimentary Works for Beginners"—the forerunner of a full and well-arranged collection of introducers to science. Mr. Tomlinson has undertaken the somewhat difficult task of conducting the unread beginner during his first scientific wanderings, and has shown himself to he well worthy of the character of a trustworthy guide. Extreme hrevity is a necessary consequence of the lowness of the publisher's price for these volumes; but this has at least been made up by a triteness of expression, and a close grappling of the principles, rather than of thc extraneous details of the vast science which instructs us in the laws of the physical world. We can hardly add a further or a better recommendation of the work, than hy stating that, within his 162 diminutive pages, the author has not once swerved from thc direct route to the point of his mission, and the gencral spirit of his observations is worthy of close imitation.

In the last page we find the following closing remarks, which will materially assist us in concluding our notice:—

"Should the young student who has followed us through this hasty sketch seek in vain for the moral of our story, and ask, 'What is the use of Natural Philosophy?' we may reply by quoting Franklin's answer to a similar inquiry, 'What is the use of a new-born infant?' The germs of all scientific research contain the elements of future strength and

usefulness. All our knowledge bears reference either to *speculation* or to *action*, and hence may be divided into the *theoretical* and the *practical*. The first constitutes the natural basis of the second, and every branch of industry has derived inestimable benefit from scientific theories. Who could have supposed that the ancient Greek geometers, while speculating on the properties of the conic sections, would be of infinite service, after a long series of ages, in renovating the science of astronomy, and bringing the art of navigation to a perfection which it would probably not have attained in our own day, but for the purely theoretical labours of Archimedes and Apollonius; so that, as Condorcet beautifully remarks, 'the sailor who has been preserved from shipwreck by an accurate observation of the longitude, owes his life to a theory conceived two thousand years ago, by men of genius who had in view only simple geometrical speculations.' Hence we must never test the value of scientific discoveries by their practical application. If not applicable now, they may become so hereafter, as the whole history of science proves. It is enough for us that our highest intellectual capacities are trained and gratified by the study of natural laws, because, in proportion as we master them, we gain power over the material universe. Our knowledge, it is true, proceeds by slow and painful steps; it is constantly obscured by error, doubt, and difficulty; but there is this cheering influence connected with studies of this kind, that the more we know, the less we have to remember; for in proportion as knowledge is collected and generalized into laws or principles, the greater is its simplicity; in proportion as we increase in real knowledge, we increase in power; for the fewer these principles are, the more *general* does each of them become, and therefore the more extended in their application, and the more power must accrue from their knowledge."

HAND-BOOK FOR THE STARS; containing Rules for finding the Names and Positions of all the Stars of the First and Second Magnitude. By H. W. Jeans, F.R.A.S. Second Edition. London, 1848. Pp. 60. Woodcuts.

Mr. Jeans is prolific in practical books, and the issuing of a second edition of his "Hand-Book" is some proof that the public appreciate his labours in a substantial manner.

As a means of discovering and identifying the principal stars, this work has been found more useful and more conveniently applicable to the purpose than a map or globe, for its pages and illustrative diagrams are at once philosophical instructors and referential tables. The author has taken the rather uncommon pains of giving due philosophical reasons for whatever he lays down as fixed data, and were this the only important point of his pages, he would deserve our thanks for it.

The three main divisions of the volume are—"Constellations north of the Zodiac," "Constellations of the Zodiac," and "Constellations south of the Zodiac;" hence, the student, or practical navigator, may direct his attention to the exact quarter of the book which contains the information he desires. Taking the principal constellations as finger-posts, the author has laid down simple methods of hitting the position of any given star by drawing lines from the more salient of the leading stars. Thus—

To find the Pole Star.

"Draw a line from β to α of the Great Bear (fig. 1, diagram of Great Bear given), and produce it about the length of the whole constellation of the Great Bear;* this line will terminate near the Pole star. As it is one of the most conspicuous in that part of the heavens, it will be easily found in this manner. The stars α and β Ursæ Majoris, used for finding the Pole star, are, for this reason, called the *Pointers*."

To find the place of the North Pole of the Heavens.

"Draw a line through the Pole star to ϵ in the Great Bear. The pole is on this line, at about 1½° from the Pole star.

"By this rule we can easily discover the position of the Pole star with respect to the pole: for the star will be to the south or north of the pole according as ϵ Ursæ Majoris is to the north or south of the Pole star. When ϵ Ursæ Majoris is 6 hours from the meridian (which may be easily found in the transit table, or estimated by the eye), the Pole star is at its greatest distance from the meridian. In this position of the Pole star, its altitude will be nearly that of the pole, or the same as the latitude of the spectator."

A complete set of tables of the "Approximate mean times of the transits of the principal stars," is appended, and completes the book.

The Admiralty and the East India Company have signified their acknowledgments of the value of the book, by issuing a copy to each ship in commission. Better credentials could not be given.

CORRESPONDENCE.

THERMOMETRIC OBSERVATIONS.

In determining the point at which melting wax becomes solid, and using different thermometers in different trials, I obtained results which did not agree. This arose from the circumstance, that the bulb of the thermometer only was immersed, and from the proportional quantity of the whole mercury in the bulb of one thermometer being different from that in the other. Would any of your mathematical friends be kind enough to favour me with an exact rule, by which, knowing the temperature of the room and the position of the bulb upon the scale, I may be able to determine the true melting point from the observed or apparent one? H. R.

Glasgow, Oct. 12, 1848.

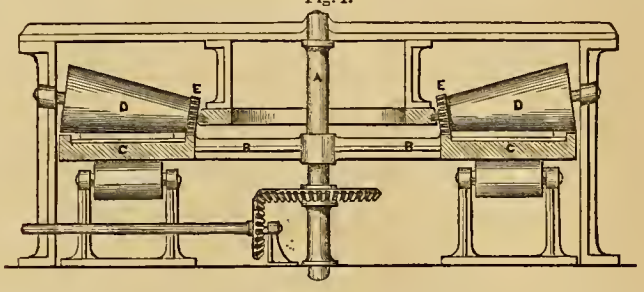
---

* "By the length of the whole constellation of the Great Bear we here mean, the distance between the two extreme stars β and η in fig. 1; the constellation itself extends over a space considerably greater than that occupied by the seven bright stars in the figure."

ROTATORY PRINTING MACHINE.

In designing this machine, I have endeavoured to produce an arrangement free from any jar in working at a high speed, and at the same time preserving a simplicity of details. Fig. 1, is a vertical section of the machine; fig. 2, is a plan with the frame removed. A, Is the main vertical shaft, which receives its motion from a horizontal shaft near the base, through a pair of bevel wheels; it has keyed upon it, a circular table, B B, five feet in diameter, carrying five forms of letterpress, C C, which, as the table revolves, are continually passed beneath the impressing cylinders, D D. These cylinders revolve in bearings in the stationary

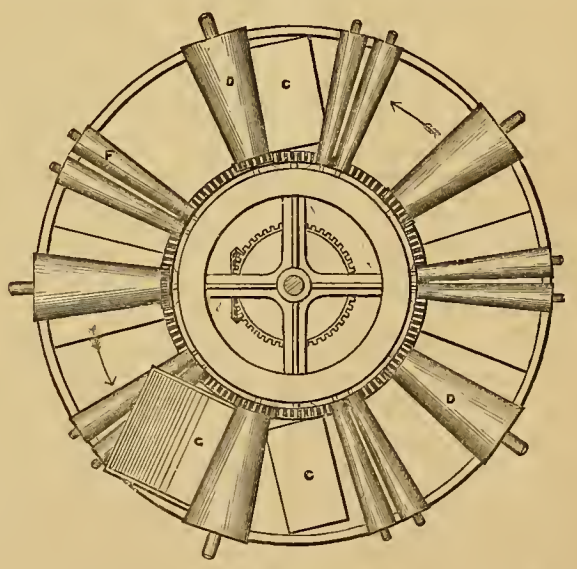
Fig. 1.



frame of the machine, and are driven by the bevel wheels, E E, which gear with a large toothed ring on the surface of the table. The inking rollers, F, are set at a little distance behind each impressing cylinder, D, and are of the ordinary kind. The paper to be printed is shown at G, where a boy stands to lay the sheets on the form just before it passes beneath the cylinder, another being posted immediately behind to take off the printed sheets; thus, for a five-roller machine, ten attendants will be required.

The grippers for securing the paper beneath the cylinders, are put in action by a simple lever and inclined plane as the table revolves. Each

Fig. 2.



time the lever comes upon the incline, the gripper is raised against the impressing cylinder, and carries forward the sheet which the boy presents. The grippers are of considerable length, and moderately flexible, with the intention of being made to act upon the paper for some distance, until it comes to the hand of the attendant. Five cylinders are represented in the sketches, but eight or any other number might be adopted. According to my calculations, the five cylinders are capable of giving 3000 or 4000 impressions per hour, printing both sides at the same time; with eight cylinders it would print 6000. It is to be understood that no tapes are required in this machine, and a great mass of complication is thus removed. In book-printing it might be easily arranged for four tables instead of two, to do the same quantity of work.

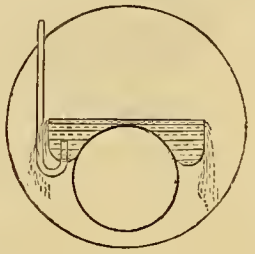
STEPHEN SHARP.

Stamford, Sept. 22, 1848.

STEAM BOILER EXPLOSIONS.—INJECTION OF COLD FEED WATER.

Boiler explosions have lately been rife in this district, but still the same apathy appears to exist on the subject, and few precautions are taken to prevent the recurrence of the terrible fatalities. Amid the endless visionary theories propounded as the cause of these disasters, the real one is very seldom touched, and when it is, no additional security is provided. For example, what can have a more dangerous effect than a sudden rush of cold feed water upon the metal of an over-heated boiler? and I can confidently say, that in the bulk of cases this is the cause of explosion.

Considering the matter in this light, I have thrown together some remarks bearing upon this particular cause, which may afford some hints for future enlargement by your correspondents. The figure represents a transverse section of a one-flue cylindrical boiler, fitted with what I term, a concave gallery, running down the entire length of the boiler, and riveted to the ends. It is placed immediately over the crown of the flue, and as it sustains no pressure, it need not be of more than $\frac{3}{16}$ths metal. Instead of the feed being thrown into the boiler to infringe directly upon the heated crown or bottom, it would be brought in by the vertical pipe, the end of which turns up into the bottom of the gallery, whence the warm water displaced by it, would fall over the sides as represented, and the cold water would never come into contact with the heated parts, should any exist.



Bilston, October 18, 1848. ROBERT BOWMAN.

ON THE FORMATION OF COAL.

Fine clay forms the bed or substratum upon which all coal rests; upon the top of this clay the Stigmaria ficoides are always found. Then follow the Ferns and Aquisitaceæ, afterwards the Sigillaria, Fossils, and then the bed of coal. The Stigmaria is found in no other stratum in the coal measures; and thus, as we have said before, it is only found underlying the coal. Therefore, that coal is connected with vegetable productions admits of positive proof, for after the germination and growth of certain plants we find the coal. But when we get into the coal, we lose every appearance of these vegetable substances, and the coal itself assumes a mineral-like form, quite different to all vegetable appearances. It is strange to account for this, for had heat been the means employed in the laboratory of nature to convert vegetable productions into mineral, then the heat would have indurated the underlying clay; but such is not the case, for it is clear no heat has ever acted upon the clay. There must, therefore, be some other chemical agent by which the vegetable matter has been converted into mineral, and this totally disconnected with heat, except so far as water or some gas may have been concerned with heat.

If heat has been employed in the formation of crystaline coal, it must have been also accompanied with water, or we must look for some other chemical means to produce the effect. Many certain proofs are given that heat was present, but it is not so apparent that water was not present also. The coal measures are much intersected with dykes of greenstone and basalt, running through them in various directions: this proves the presence of heat, but this did not occur until the coal was formed. The sandstone about Newcastle is too friable for building purposes; doubtless this occurs from the presence of heat, for sandstone is rendered friable by being burned: and the reason why we do not find water present in the sandstone, arises from its porous nature. It has therefore all the results which heat would produce, and, by reason of its nature, it has been unassisted by water.

We must look also at what we find upon the top of a seam of coal, as well as what underlies it. It is proved that many Fossils—for instance, the Fern tribe especially—are found there. These Ferns are tropical plants, showing that great heat was present even in our northern climates when these plants grew in this position. This heat might be the result of the general great heat of the earth in the time of the coal formation. We know, too, that the Fern tribe require great moisture for their growth. The question then arises, whether what is found under the coal, and what is found upon the coal, are not the remains of these substances, out of which coal was formed, but that these substances remained unconverted into coal, being mixed with clay and other matter? These vegetable productions enclose it on both sides, and differ in themselves, only as we might expect one species of vegetation to differ from another, as successive genera succeed each other, or as one generation of vegetation provides for that of another kind, or is preparative for the growth of the succeeding one. That these layers above and below are preserved, and have not mixed with, or have not become coal, is easily accounted for, because they are mixed with clay or other matter, being the limits or confines of the system. From this reasoning we may come to a pretty accurate conclusion, that coal was most probably formed out of vegetable substances; but how it was reduced to its present mineral state does not yet appear.

It has been presumed by Whiston, that, prior to the creation of man, the earth had no diurnal rotation, but that it only moved round the sun in an annual course. If so, then six months' day, and six months' night, must have been the condition of all parts of the globe. Would not then this long night be serviceable to the growth of certain vegetation? We know that the Boletus of tropical climes will grow up 6 or 8 feet in a single night, and will be some feet in diameter. To this it may be objected, that the Fern tribe require light, but it is not conclusive that they had not light. On the contrary, the light would be continuous for a certain time—for six months—and the growth of the species might be accelerated by such a position of things. Nor is it proved that the Stigmaria, &c. require light for their growth. Leaving this speculative philosophy, founded upon Whiston's theory, we may resume our researches at some other period, remarking, that a carboniferous atmosphere would rapidly increase the growth of certain vegetable products. We know that, under the present disposition of our globe, carbonic acid gas is precipitated in the night to the surface of the earth, and this accounts for the rapid growth of the African Boletus, and for the growth of vegetables in general during the night.

Glasgow, Oct. 4, 1848. G. R. B.

ON THE CONDENSATION OF STEAM.

May I beg the favour of your inserting a few lines in your valuable Journal, as I am sure that some of your intelligent correspondents are able to inform me, what amount of cooling surface is required to condense a certain quantity of steam of a given pressure—say the constant cooling temperature to be 60° Fahrenheit, the pressure of steam 60 lbs., and the quantity 400 cubic feet per minute?

London, Oct. 6, 1848. H. P. C. E.

A PRACTICAL QUESTION.

Coals are frequently raised up the pit by a steam-engine, turning a cylindrical drum, or two separate drums, upon which two flat ropes coil, as the drum or drums revolve, so that each turn of the drum increases the diameter of the coil two thicknesses of the rope, its thickness being 1 inch. The engine is fixed at any indefinite distance from the pit, and the rope leads from opposite sides of the drum to two pulleys elevated above the pit's mouth, such elevation being indefinite. By this means, whilst one rope descends the pit, the other ascends.

To the end of each rope, the weight of which is, p, pounds per lineal foot, is attached a basket or corf, weighing, b, pounds, and each basket contains, c, lbs. of coal.

The diameter of the drum is required when the depth of the pit is, l, feet, so that the steam-engine may have the same resistance to overcome when the basket of coal is just lifted from the pit's bottom, as when it reaches the mouth of the pit.

Note.—The point of suspension of the respective matters, rope, basket, and coal, to be taken at the radius of the drum + half the thickness of the rope, and the same as respects the coil, so that if $r =$ the radius of the drum or coil, $r + \frac{1}{2}$ inch is the point of suspension.

15, *Goulden Terrace, Islington, October* 9, 1848. JOHN CURR.

ON CARBONIC ACID GAS AS A PREVENTIVE OF CHOLERA.

I think it is the duty of every individual who has noticed any peculiar phenomenon respecting this disease to give it publicity; and having seen the remarks in your Journal on the salutary effects of the presence of carbonic acid gas as a preventive of this disease, I beg to lay before the public a few observations tending to substantiate the same results. It was noticed by me, that in those dwellings where the cholera raged in its last visit, the house-fly totally disappeared. This proved that something was wanting in these dwellings which they were ordinarily accustomed to possess, or that something was present which was not commonly to be found there. Now, we do know that, by abstracting the

carbonic acid gas from an apartment, the house-fly is destroyed; for, if you place a few small plates full of caustic lime in an apartment infested by them, they die in a very short time, the lime taking up the carbonic acid gas that is present in the atmosphere.

If the presence of carbonic acid gas should prove a preventive of the cholera, carbonic acid gas may be cheaply made hy pouring some sulphuric acid upon some chalk mixed with plenty of water. This might he supplied to every room in a house, and would prove a cheap remedy; or a brazier of charcoal might be kept burning iu the hall of every house, which would supply carbonic acid gas at a cbeaper rate; but care mnst be taken that every room-door of the house is kept constantly open night and day, for fear of suffocation. There is no douht, that to the inflnence of the earbonic acid gas may be attributed the safety from cholera which was found in some parts of the Continent, where they burned tar lamps in their honses. It was thought at the time that the fumes of the tar was the preventive, but I think the cases you have enumerated prove satisfactorily, that the carbonic acid gas was the point of safety. Really, this important subject should have the attention of the medical men of this town. Every inquiry upon this fact, or statement respecting carbonic acid gas as a curative of the cholera, shonld have prompt attention and investigation. To urge this upon their attention is the object of this letter; and I trust this appeal to them will not be in vain. G. R. B.

Glasgow, Oct. 23, 1848.

WHO ORIGINATED THE RAILWAY SYSTEM?

In the different memoirs of George Stephenson which have appeared in all quarters since the death of the subject of them, the whole undivided merit of originating the railway system has been freely given to him, whilst the claims of other obscure but talented individuals have been utterly neglected. The following letter has resulted from the publication of such a statement in the *Derby Reporter*:—

"In the conrse of the biographical sketch of the late George Stephenson, C.E., in the *Derby Reporter*, there appear to be a few points requiring explanation, which it is just and proper shonld be made known to the public. It does not state that be was copartner with Mr. William James of London, land agent and engineer in the locomotive patent, or that the latter was the actual originator of the railway system forty years since, by his proposing a line from these towns to Birmingham, through the colliery districts, and a communication from thence by canal to Stafford, and by the river Avon to Bristol, and subsequently his more grand project, the Manchester and Liverpool line, for engine-passenger traffic; and his letter to the Prince Regent, in 1815, shows that he entertained the idea of rapid locomotion by steam and other agents several years antecedent to it, but the time was not ripe for the project. The biographical notice gives to Mr. Stephenson the undivided honour, by calling him the 'father of railways,' when it should have referred principally to the improved locomotive engine. The railway machinery has been brought to its present perfection by the combined engineering talent of the nation. William James was really the leader, and the only successful agitator of the subject—the first person who gave the impulse to the ponderous mass of inertia in the public mind, by which vigorous effort the mighty movement commenced, and has been since kept up by Mr. G. Stephenson and his talented son, and other eminent engineers of the age. No one could have succeeded in that undertaking but such a man as William James, who all his life had been accustomed to struggle with and execute difficult projects, who possessed a wide connection with the nobility and great landed proprietors, with whom he was accustomed to mix, and to negotiate matters of business. Being a man of good education, tact, and of business habits, he was in all respects the very best captain to attack the strongholds of ancestral prejudice, followed up and supported by Stephenson's practical ability. Mr. Robert Stephenson was then a minor, and had not finished his education at the University, but was acting as an assistant-surveyor on the line, under Mr. James, two years before his father received the appointment of engineer, which had been offered to Mr. James, but which his peculiar circumstances prevented his accepting; and I understood at the time that it was through this recommendation that Stephenson proposed three hundred pounds to be presented to the widow of his partner by the Company. It is quite evident, that if two such minds had not been brought happily into apposition, that the railway system might have been successfully opposed—that the engineering talents of a Stephenson might not have been known, and that all the iron sleepers might have slept on still in mother earth, and its great benefits denied to the present generation. To William James alone belongs the merit of being its earliest agitator, *in all parts* of the kingdom—in making the survey of the first line, and organizing the first Company, and lodging the first Report and Plans of the Manchester and Liverpool Railway. And he had done much in experiments and surveys in various places, but without patronage, at his own expense, previously. This ought not to be forgotten or overlooked; indeed, if ever a national monument should be erected commemorative of this great benefaction, I should propose that the busts of James and Stephenson should be placed together, as they have equal claim to the nation's gratitude. The contrast is remarkable in the success in life of the two parties, and there appears to be some mistake and confounding of the labours and position of each. William James was the party who 'underwent something akin to persecution;' he it was who had to bear the first shock of the contest; and this persecution seems to have descended on his family. The taunts of the vulgar-minded only stimulated him to acts of extraordinary energy, kept up for nights and days, until they gave way from natural exhaustion, or change of events and situation. The sons of genius do not often combine within themselves the faculty of self-interest—the especial glory and climax to be aimed at in vulgar eyes—and thus, for being rich and becoming poor for the public benefit, he has been reviled at, and pointed at with the finger of scorn *during* his agitation of this project. William James was, before he commenced his speculative career, Lord of Snowford Manor, and raised one hundred men as volunteers in Warwick at the time of the threatened invasion, was elected major, and was presented with a sword worth sixty guineas on their being disbanded; and it was shown that his property exceeded £100,000 in value. The last reserve of this fortune was expended in this project of the railway system. He lived through the pelting of the wintry storm, but his more fortunate coadjutor, without education or address to propose a public measure, rose from poverty to wealth in the summer glory of the scheme, and died proprietor of Tapton House. He deserves all the honours that have been heaped upon him; but does not Mr. James's *successful* efforts and *personal* sacrifices in this and many other great undertakings, also deserve commemoration and regard? I was at Liverpool for my health at the period of the first survey, and had opportunities of seeing the parties almost daily, and I do think you will do justice to the memory of William James (originally a Warwickshire man), by introducing this humble sketch into your valuable Journal. "A Coal and Ironmaster of Staffordshire.

"*Stafford, September* 7, 1848."

The claims of Mr. James were indeed fairly enough allowed in 1845, when a committee of engineers and others, amongst which the names of the younger Stephenson, Brunel, Locke, Errington, and others, are to be found, was organized for promoting a general subscription on behalf of the children of the deceased engineer. For reasons with which the public has never been acquainted, this movement, so energetically begun, has sunk to nothing, and few are now aware that such a scheme was ever afloat. If the men whose names we have mentioned could so lately have given in their acknowledgments of the great services of this ill-fated projector, we would ask what has now become of their then overflowing sympathy? or why should not they, at this, the eleventh hour, award that sympathy and substantial reward to the sons and daughters of such a father?

Whilst we pen these remarks, the memory of a third "originator" comes before us—Mr. Gray of Exeter, the so-called "Railway Pioneer." Gray's claims go no further back than 1820, when his "Observations on a General Iron Railway" made their appearance. In the late columns of the *Manchester Examiner* is given an extract from Sir Richard Phillips' "Morning Walk to Kew," where he alludes to the Surrey Tram Railway, the first established in England, namely, in 1801, as follows:—

"I found renewed delight in witnessing at this place (Wandsworth) the economy of horse labour on the iron railway; yet a heavy sigh escaped me as I thought of the inconceivable millions which have been spent about Malta, four or five of which might have been the means of extending double lines of iron railway from London to Edinburgh, Glasgow, Holyhead, Milford, Falmouth, Yarmouth, Dover, and Portsmouth! A reward of a single thousand would have supplied coaches and other vehicles, of various degrees of speed, with the best tackle for readily turning out; and we might, ere this, have witnessed our mail-coaches running at the rate of ten miles an hour, drawn by a single horse, or impelled fifteen miles an hour by Blenkinsop's steam-engine. Such would have been a legitimate motive for overstepping the income of a nation; and the completion of so great and useful a work would have afforded rational ground for public triumph in general jubilees!"

This was in 1813, and consequently seven years before Mr. Gray had ever appeared in the field; but, putting this out of the question, it can never be said hy his most sanguine friends that he possessed a fraction of the practical notions so necessary for the consummation of the railway project; and whilst he was dreaming of cog-wheel rails, his practical contemporaries had actually put in practice the edge-rail system, all along so strenuously opposed by him.

We are fast approaching the time when men of mere genius will be decmed little better than stumbling-blocks in the way of improvement, for all our experiences show that the greatest genius makes also the greatest blunders. Whilst we deplore the wretched fate of this class of men, who, with talents elsewhere unapproached, have yet hardly a grain of the ballast of common sense, we cannot but feel that their miseries, however undeserved, are for the most part attributable only to themselves.

The *Morning Chronicle* has thus noted the death of the ill-fated Mr. Gray, whose labours have met with nothing more than this brief summary:—

"During the last week, Thomas Gray, whose friends claim for him the titles of 'author of the railway system,' and the railway 'pioneer,' died at Exeter, in the 61st year of his age. Though not an engineer, he was contemporary with the late George Stephenson. His name was brought into note by the publication, in 1820, of a work entitled 'Observations on a General Iron Railway, or land steam conveyance to supersede the necessity of horses in all public vehicles, showing its vast superiority in every respect over all the present pitiful methods of conveyance by turnpike-roads, canals, and coasting traders.' At the time Gray's book was written, all that was known of railways was as they then existed in the rude tramways at Newcastle and its collieries, and considerably before the construction of those earliest of our railways, the Stockton and Darlington, Liverpool and Manchester. The gist of Gray's suggestion was to carry out a comprehensive railway at one stride over the whole United Kingdom; in fact, to make a simultaneous system to all the principal towns, instead of making the work a labour of section and degree. The progress of the railway system, however, proved that this was impracticable in many, but more especially in monetary points of view, and the suggestion, from its very comprehensiveness, perished. In 1825, he petitioned Parliament and Sir R. Peel, but received no encouragement. Latterly he was reduced to poverty, and sold glass on commission. Appeals were made to the railway world on his behalf, but they met with no response, and it is said that he died broken-hearted."

ON THE MAGIC SQUARE OF THE CHESS-KNIGHT'S MARCH.

The Knight's move has given occasion for several mathematical investigations, but none have resulted in a more singular combination than the magic square, now presented to our readers. It is the invention of William Beverley, Esq., and first appeared in the pages of our contemporary, the Philosophical Magazine.

The square, fig. 1, is formed by placing the Knight, in the first instance, on the Black Queen's Rook square, numbering that square 1; then for the second move taking the Knight to the Queen's Knight's second square, numbering that 2, and so on; each square being num-

bered in succession (as in the figure), until all have been covered, and the last move of the Knight (his 64th) to the Queen's Knight's square has completed the figure. Fig. 2 is the reverse of fig. 1, the moves of the Knight commencing, in this instance, where they terminated in the former one; the backward movement in no way affecting the peculiarities of the square, the principal properties of which are the following:—

Fig. 1.

Cols.	1	2	3	4	*a* 5	6	7	8
9	1	30	47	52	5	28	43	54
10	48	51	2	29	44	53	6	27
11	31	46	49	4	25	8	55	42
12	50	3	32	45	56	41	26	7
c 13	33	62	15	20	9	24	39	58 *d*
14	16	19	34	61	40	57	10	23
15	63	14	17	36	21	12	59	38
16	18	35	64	13	60	37	22	11
				b				

Fig. 2.

Cols.	1	2	3	4	*a* 5	6	7	8
9	64	35	18	13	60	37	22	11
10	17	14	63	36	21	12	59	38
11	34	19	16	61	40	57	10	23
12	15	62	33	20	9	24	39	58
c 13	32	3	50	45	56	41	26	7 *d*
14	49	46	31	4	25	8	55	42
15	2	51	48	29	44	53	6	27
16	47	30	1	52	5	28	43	54
				b				

1. The sum of each of the horizontal and vertical columns is 260. Thus, the top row of fig. 1: $1+30+47+52+5+28+43+54=260$; and the left hand vertical column of the same figure: $1+48+31+50+33+16+63+18=260$.

2. The large figures being divided into four, as shown by the dotted lines, give eight magic squares of 130, each of the cross and vertical rows amounting to that number.

3. The secondary squares last mentioned, again quartered, furnish thirty-two magic squares, containing four numbers in each, whose total is 130 in each, as in the little square of four numbers in the right hand bottom corner of fig. 2: $6+27+43+54=130$.

Fig. 3.

Cols.	1	2	3	4	5	6	7	8
11	31	46	49	4	25	8	55	42
12	50	3	32	45	56	41	26	7
13	33	62	15	20	9	24	39	58
14	16	19	34	61	40	57	10	23

Fig. 4.

Cols.	1	2	3	4	5	6	7	8
11	34	19	16	61	40	57	10	23
12	15	62	33	20	9	24	39	58
13	32	3	50	45	56	41	26	7
14	49	46	31	4	25	8	55	42

4. The two top and the two bottom cross rows of each figure being removed, leave double magic squares of 130; as in fig. 3, taken from fig. 1, and fig. 4, taken from fig. 2. The cross rows thus removed, placed one upon the other, also form double magic squares of 130; as in fig. 5, the two top and the two bottom rows of fig. 1, and fig. 6, formed similarly from fig. 2.

Fig. 5.

Cols.	1	2	3	4	5	6	7	8
9	1	30	47	52	5	28	43	54
10	48	51	2	29	44	53	6	27
15	63	14	17	36	21	12	59	38
16	18	35	64	13	60	37	22	11

Fig. 6.

Cols.	1	2	3	4	5	6	7	8
9	64	35	18	13	60	37	22	11
10	17	14	63	36	21	12	59	38
15	2	51	48	29	44	53	6	27
16	47	30	1	52	5	28	43	54

5. The vertical line, *a b*, bisects all the cross rows, and the odd numbers on one side of the line added to the even numbers on the other side of the line in the same row amount to 130. Thus, in the bottom cross row of fig. 2, the odd numbers to the left, $47+1$, added to the even numbers on the right, $28+54=130$; and the odd numbers on the right, $5+43$, added to the even numbers on the left, $30+52=130$. The sums total of all the odd numbers on each side of the line, *a b*, are equal; and so also are the totals of the even numbers; but the sum of all the odd numbers in the figure is one-half of 64 (*i. e.* 32) less than the sum of all the even ones; the odd numbers amounting to 1024 ($=64\times16$), and the even numbers amounting to 1056 ($=64\times16+2)\ 16$).)

6. The even numbers above the horizontal line, *c d*, added to the odd numbers below the line, and the reverse, amount to 130 in all the vertical columns, except the first and third; in these, the odd numbers below the line in one column must be added to the even numbers above the line in the other. Thus, $1+31$ in the first column of fig. 1, added to $34+64$ in the third column, amount to 130.

7. The top and bottom, 2d and 7th, 3d and 6th, 4th and 5th numbers, in the same vertical column, added together, amount to 65. The peculiarity last mentioned prevails, however, in the first and third columns in this instance also; thus, the top number of the second column of fig. 2, 35, added to the bottom number of the same column, $30=65$; but the top number in the first column, 64, must be added to the bottom number of the third column, 1, to amount to 65—and so on for the other numbers.

The above constitute the most remarkable peculiarities of these curious figures; our readers will, however, find, upon a little examination, that there are several other properties belonging to them, such as the apposition of the numbers, &c., which our space forbids us to point out more particularly. D.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—EIGHTEENTH MEETING.—Swansea, Aug. 9.

Section A.—Mathematical and Physical Science.

"On the Velocity and Height of Waves," as observed by Capt. Stanley, being the result of Experiments made on board H.M.S. Rattlesnake.—The method I adopted for the determination of the length and speed of the sea, was to veer a spar astern by the marked lead line, when the ship was going dead before the wind and sea, until the spar was on the crest of one wave, while the ship's stern was on the crest of the preceding one. After a few trials, I found that, when the sea was at all regular, I could obtain this distance within 2 or 3 fathoms, when the length of wave was 50. In order to ascertain the speed of the sea, the time was noted when the crest of the advancing wave passed the spar astern, and also the time when it reached the ship; and by taking a number of observations, I have every reason to believe we have obtained a result not very far from the truth. The officer noting the time in all these observations having only to register the indications of the watch when the observer called "Stop," had no bias to induce him to make the differences more regular. For measuring the height of the waves, I adopted a plan recommended to me by Mrs. Somerville, which I have tried for ten years with great success. When the ship is in the trough of the sea, the person observing ascends the rigging until he can just see the crest of the coming wave on with the horizon, and the height of his eye above the ship's water-line will give a very fair measure of the difference of level between the crest and hollow of a sea. Of course, in all these observations, the mean of a great many have been taken; for even when the sea is most regular, apparently there is a change in the height of the individual waves. In order to show how closely the different results came, I give the observations on different days from which they were deduced:—

Experiment, No. 1.

Length of sea, 55 fathoms; speed of ship, 7·2 knots; height of wave, 22 feet; time the wave took in passing from spar to stern, 10 seconds; speed of sea deduced, 27′ per hour.

Experiment, No. 2.

Times observed of wave passing from spar to stern.

Sec.
8·7
7·0
9·2 Length of wave, 43 fathoms.
6·3 Average height, 20 feet.
7·0 Speed of ship, 6 knots.
8·6 Speed of wave deduced, 24·5 nautical
8·8 miles per hour.
8·4

8/64·0

8·0 Mean time of wave going from spar to stern.

Experiment, No. 3.

Sec.
7·4
13·0 Length of wave, 50 fathoms.
10·7 Height of wave, 20 feet.
10·0 Speed of ship, 6 knots.
10·2 Speed of wave deduced, 24 nautical
9·0 miles per hour.

6/60·3

10·0 Mean time of wave passing from spar to stern.

Experiment, No. 4.

Sec.
7·5
7·0
10·0 Length of wave, 30 to 60 fathoms.
9·0 Height of wave.—
9·0 Speed of ship, 5 knots.
10·0 Speed of wave deduced, 22·1 nautical
9·0 miles per hour.
8·0
9·5

9/79·0

7·8 Mean time of wave passing from spar to stern.

Experiment, No. 5.

Length of wave, 33 fathoms.
Speed of ship, 6 knots.
Speed of wave deduced, 22·1 nautical miles per hour.

Experiment, No. 6.

Times observed of wave passing from spar to stern.

Sec.
12·0 Length of wave, 57 fathoms. } Sea irregular; observations not very good.
9·0
7·5 Height of wave, 22 feet.
10·5 Speed of ship, 7 knots.
10·5 Speed of wave deduced, 26·2 nautical
13·0 miles per hour.

6/62·5

10·4 Mean time of wave going from spar to stern.

Experiment, No. 7.

Sec.
9·5
6·5 Length of wave, 35 fathoms.
8·0 Height of wave, 17 feet.
8·5 Speed of ship, 7·8 knots.
7·0 Speed of wave deduced, 22 nautical
12·5 miles per hour.
10·0

7/62·0

8·9 Mean time of sea passing from spar to stern.

Summary of Observations.

Date. 1847.	Number of Observations.	Force of Wind.	Speed of Ship.	Height of Wave.	Length of Wave.	Time of Wave passing from spar to stern.	Speed of Sea deduced.	Remarks.
April 21		5	Knots. 7·2	Feet. 22	Fms. 55	Second. 10·0	Knots. 27·	Ship before the Wind with a heavy following Sea.
23	8	5	6·0	20	43	8·0	24·5	Ditto.
24	6	4	6·0	20	50	10·0	24·0	Ditto.
25	9	4	5·0		35 to 40	7·8	22·1	Sea irregular.
26		4	6·0		33	7·4	22·1	Heavy following Sea.
May 2	6	(4·5)	7·0	22	57	10·4	26·2	Sea irregular—observations not very good in consequence.
3	7	5	7·8	17	35	8·9	22·	Wind and Sea a little on port quarter.

Note.—The Numbers denoting the strength of the Wind are those used by Admiral Beaufort.

Mr. Scott Russell and Lord Adair made some remarks on this communication; in the course of which the latter said, that few persons could realize the magnificent effect of standing on the cliffs of the west coast of Ireland, and observing the great breakers rolling in from the Atlantic, some of which he had, by a method exactly similar to that used by Captain Stanley, convinced himself were 50 feet high, and occasionally they even reached the enormous magnitude of 150 feet.

"On rendering the Electric Telegraph subservient to Meteorological Research," by J. Ball, Esq.—What is popularly termed the weather, is a general expression for the physical condition of the atmosphere with reference to heat, pressure, moisture, and the velocity and direction of its motion. Two classes of causes determine these conditions at any given point of the earth's surface. The first class may, for short periods of time, be considered as constants, depending on the position of the point of observation on the globe, and the physical conformation of the adjoining district. The second class, upon which the proverbial uncertainty of the weather depends, depend upon the relative influence of each portion of the atmosphere upon those surrounding it, by virtue of which a disturbance of equilibrium at any one point is rapidly propagated in all directions. In common language this is expressed by saying, that the direction of the wind is at once the cause and the indication of changes of the weather. However far we may be from a general solution of the problem of atmospheric disturbances, meteorologists have made considerable progress in tracing the connection between successive states of the weather owing to the mutual influence of contiguous portions of the atmosphere. These cases have been studied *à posteriori*, comparing the known results with observations extending over considerable areas. Now that we have the means of receiving information in an indefinitely short space of time by the Electric Telegraph, these problems, under favourable circumstances, may be studied *à priori*.* In London we may receive instantaneous intelligence of the condition of the atmosphere, as to the five above-mentioned elements, from nearly all the extremities of Great Britain; with a delay of about four hours we can have similar intelligence from the western part of Ireland, and with a still shorter delay, our communications may extend to the centre of France, the banks of the Rhine, and even to the frontiers of Hungary and Poland. I do not pretend to say, that with such elements for calculation we should at once be enabled to predict changes in the weather with absolute certainty. It would require some time to eliminate the action of accidental and local causes at particular stations; but there is no reason to doubt, that in a short time the determinations thus arrived at would possess a high degree of probability. The ordinary rate at which atmospheric disturbances are propagated, does not seem to exceed twenty miles per hour; so that with a circle of stations, extending about 500 miles in each direction, we should in almost all cases be enabled to calculate on the state of the weather for twenty-four hours in advance.

Dr. Lloyd said he supposed Mr. Ball was aware, that Prof. Lamont of Munich had rendered the ordinary telegraph subservient in that country to the purposes proposed by Mr. Ball. By having the state of the barometer, thermometer, and wind telegraphed from every part of Bavaria, he was often enabled to foretell storms and other atmospheric changes more than twenty-four hours before they occurred, to the no small astonishment of those who were not aware of the means he used.

"On a Means of determining the apparent Solar Time by the Diurnal Changes of the Plane of Polarization at the North Pole of the Sky," by Prof. Wheatstone.—A short time after the discovery, by Malus, of the polarization of light by reflection, it was ascertained by Arago that the light reflected from different parts of the sky was polarized. The observation was made in clear weather, with the aid of a thin film of mica, and a prism of Iceland spar; he saw that the two images projected on the sky were, in general, of dissimilar colours, which appeared to vary in intensity with the hour of the day, and with the position, in relation to the sun, of the part of the sky from which the rays fell upon the film. The first attempt to assign a law to the phenomena of atmospheric polarization was made by Prof. Quetelet of Brussels, in 1825, in the following terms:—"If the observer consider himself as placed in the centre of a sphere, of which the sun occupies one of the poles, the polarization is at its maximum at the different points of the equator of this sphere, and goes on diminishing in the ratio of the squares of the sines unto the poles, where it is *null*." This law would be true, did the reflected light proceeding from the part of the sky regarded arise solely from the direct light of the sun sent to that part; but other secondary reflections occur which complicate the result, and give rise to the neutral points since discovered by Arago, Babinet, and Brewster. But for the purpose of explaining the principle of the instrument now submitted to the examination of the Section, we need not take into consideration the intensity of the polarization of the part of the sky to which it is directed; the plane of polarization for the time being is the only thing we need concern ourselves about, and a very simple expression, stated first, I believe, by M. Babinet, defines the position of this plane for any given point of the sky. It is this:—"For a given point of the atmosphere, the plane of polarization of the portion of polarized light which it sends to the eye, coincides with the plane which passes through this point, the eye of the observer and the sun." The truth of this law may be easily demonstrated, without any refined apparatus, in the following manner:—Let the observer be provided with a Nicols prism and a plate of Iceland spar, cut perpendicularly to the axis, and stand with his back towards the sun; keeping the diagonal of the prism always in the same vertical plane, let him direct it successively to every point of the sky within that plane; the intensity of the polarization, indicated by the brightness of the coloured image, will vary very considerably at these different points, but the plane of polarization, indicated by the upright position of the black or white cross, as the case may be, will remain unchanged. I leave out of consideration for the present the inversion of the plane of polarization, observed occasionally near the horizon below the neutral point. If we direct our analyzing apparatus to the zenith during the whole day, the change in the plane of polarization of that point of the sky will correspond with the azimuths of the sun. Let us now turn our attention to the north pole of the sky. As the sun in its apparent daily course moves equably in a circle round this pole, it is obvious that the planes of polarization at the point in question change exactly as the position of the hour circles do. The position of the plane of polarization of the north pole of the sky will, at any period of the day, therefore indicate the apparent or true solar time. The point of intersection of the hour circles, or the north pole of the sky, corresponds on only two days of the year with the maximum intensity of polarization; these days are the equinoxes: on all other days the points of maximum polarization of the respective hour circles describe a circle round the point of intersection; but the angular distance therefrom, which is greatest at the solstices, never exceeding 23° 28′, the polarization has always sufficient intensity to exhibit brilliant colours in films of selenite, &c. These points being premised, I proceed to describe the new instrument which I have called the Polar Clock or Dial. It is thus constructed:—At the extremity of a vertical pillar is fixed, within a brass ring, a glass disk, so inclined that its plane is perpendicular to the polar axis of the earth. On the lower half of this disk is a graduated semicircle, divided into twelve parts (each of which is again subdivided into five or ten parts), and against the divisions the hours of the day are marked, commencing and terminating with six. Within the fixed brass ring containing the glass dial-plate, the broad end of a conical tube is so fitted that it freely moves round its own axis; this broad end is closed by another glass disk, in the centre of which is a small star or other figure, formed of thin films of selenite, exhibiting, when examined with polarized light, strongly contrasting colours; and a hand is painted in such a position as to be a prolongation of one of the principal sections of the crystalline films. At the smaller end of the conical tube, a Nicols prism is fixed, so that either of its diagonals shall be 45° from the principal section of the selenite films. The instrument being so fixed that the axis of the conical tube shall coincide with the polar axis of the earth, and the eye of the observer being placed to the Nicols prism, it will be remarked that the selenite star will in general be richly coloured; but as the tube is turned on its axis, the colours will vary in intensity, and in two positions will entirely disappear. In one of these positions, a small circular disk in the centre of the star will be a certain colour, red for instance, while in the other position it will exhibit the complementary colour. This effect is obtained by placing the principal section of the small central disk 22½° from that of the other films of selenite which form the star. The rule to ascertain the times by this instrument is as follows: The tube must be turned round by the hand of the observer until the coloured star entirely disappears, while the disk in the centre remains red; the hand will then point accurately to the hour. The accuracy with which the solar time may be indicated by this means, will depend on the exactness with which the plane of polarization can be determined; one degree of change in the plane corresponds with four minutes of solar time. The instrument may be furnished with a graduated quadrant, for the purpose of adapting it to any latitude; but if it be intended to be fixed in any locality, it may be permanently adjusted to the proper polar elevation, and the expense of the graduated quadrant be saved: a spirit level will be useful to adjust it accurately. The instrument might be set to its proper azimuth by the sun's shadow at noon, or by means of a declination needle; but an observation with the instrument itself may be more readily employed for this purpose. Ascertain the true solar time by means of a good watch and a time equation table; set the hand of the polar clock to correspond thereto, and turn the vertical pillar on its axis until the colours of the selenite star entirely disappear. The instrument then will be properly adjusted. The advantages a polar clock possesses over a sun-dial are—1. The polar clock being constantly directed to the same point of the sky, there is no locality in which it cannot be employed; whereas, in order that the indications of a sun-dial should be observed during the whole day, no obstacle must exist at any time between the dial and the places of the sun, and it therefore cannot be applied in any confined situation. The polar clock is consequently applicable in places where a sun-dial would be of no avail, on the north side of a mountain or a lofty building for instance. 2. It will continue to indicate the time after sunset and before sunrise; in fact, so

* The *Express* London evening paper has adopted this idea, and is publishing, by aid of the Electric Telegraph Company, the state of the weather in different parts of the kingdom at a given time in each day.

long as the rays of the sun are reflected from the atmosphere. 3. It will also indicate the time, but with less accuracy, when the sky is overcast, if the clouds do not exceed a certain density. The plane of polarization of the north pole of the sky moves in the opposite direction to that of the hand of a watch: it is more convenient therefore to have the hours graduated on the lower semicircle, for the figures will then be read in their direct order, whereas they would be read backwards on an upper semicircle. In the southern hemisphere the upper semicircle should be employed, for the plane of polarization of the south pole of the sky changes in the *same* direction as the hand of a watch. If both the upper and lower semicircles be graduated, the same instrument will serve equally for both hemispheres.—Several other forms of the polar clock were then described; we shall confine our description to one among them, which, though much less accurate in its indications than the preceding, beautifully illustrates the principle. On a plate of glass, twenty-six films of selenite of equal thickness are arranged radially in a semicircle; they are placed so that the line bisecting the principal sections of the films shall correspond with the radii respectively, and figures corresponding to the hours are painted above each film in regular order. This plate of glass is fixed in a frame, so that its plane is inclined to the horizon 38° 32′, the complement of the polar elevation; the light passing perpendicularly through this plate falls at the polarizing angle, 56° 45′, on a reflector of black glass, which is inclined 18° 13′ to the horizon. This apparatus being properly adjusted, that is, so that the glass dial-plate shall be perpendicular to the polar axis of the earth, the following will be the effects when presented towards an unclouded sky. At all times of the day the radii will appear of various shades of two complementary colours, which we will assume to be red and green; and the hour is indicated by the figure placed opposite the radius which contains the most red: the half hour is indicated by the equality of two adjacent tints.

"Of the Resistance of the Air to Pendulums," by G. G. Stokes, Esq.—The results obtained from the common theory of fluid motion, in which the pressure is supposed equal in all directions, for the resistance of the air to an oscillating sphere or cylindrical rod, do not agree with the experiments of Bessel and Baily, the discrepancy being so much the greater as the radius of the sphere or rod is smaller. The author stated that he had solved the problem in the cases of the sphere and cylinder, using, instead of the common equations, the equations which he had given in the eighth volume of the Cambridge Philosophical Transactions, which had been previously obtained by different methods by Navier, by Poisson, and by M. de Saint-Venant. These equations contain one arbitrary constant, the value of which, obtained from one experiment, ought, if the theory were correct, to satisfy the others; or, which comes to the same, different experiments ought to lead to the same value of the constant, except so far as depends on errors of observation. Three of Baily's experiments, made on cylindrical rods of very different diameters, which gave results very different from one another, and from that obtained from the common theory, led to very nearly the same value for the arbitrary constant, and this value satisfied very nearly the experiments made on spheres suspended by fine wires.

Section B.—Chemical Science, including its Application to Agriculture and the Arts.

"Researches on the Analogy of the Existences or Forces—Light, Heat, Electricity, Magnetism, and Gravitation," by Mr. J. Goodman.—The author supposes he has proved the identity of this principle from the fact, that potassium, when ignited is found to possess a vast amount of caloric, and to evince calorific phenomena, of which no other solid substance in nature is capable; and therefore it is more than probable that its extraordinary chemical and electrical powers are derived from the quantity of caloric which it contains. As much as the analogy of chemical and electrical phenomena is shown by their being the most strongly marked in the same substance, so also is it equally manifest that chemical and electrical phenomena are truly the properties of heat—since heat is the existence which at all times so abundantly, and beyond all other forces, predominates in potassium, in which these phenomena are displayed in the highest degree. Lastly, it is evidently manifested, says the author, that chemical and electrical phenomena are one and the same thing, because the substance producing the highest chemical, developes also the highest electrical phenomena—so now it is equally shown, that chemical and electrical forces and caloric are one and the same thing, because the substance developing the highest chemical and electrical powers, displays also the greatest capacity for, and contains the highest and most intense quantity of, heat.

Section C.—Geology and Physical Geography.

President—Sir H. T. De la Beche.

Vice-Presidents—Mr. G. B. Greenough, The Dean of Llandaff, The Dean of Westminster, Sir P. Egerton.

Secretaries—Mr. S. Benson, Prof. Oldham, Prof. Ramsay.

"On the Geology of Portions of South Wales, Gloucestershire, and Somersetshire," by Sir H. T. De la Beche.—The rocks of this district have originated in several distinct ways: some have had a mechanical origin, and consist of the detritus of older rocks broken into fragments or reduced to powder, and brought down from the land by rivers, or worn by the breakers from the coast; others have been deposited from a state of chemical solution, like some of the limestones; and some have been formed almost entirely from the aggregation of organic remains. The materials obtained from the destruction of the older rocks have been employed over and over again in the formation of those of later date. 1. The most ancient strata of the district have been denominated Cambrian and Silurian; the former may be seen in Pembrokeshire, towards St. David's. They contain the earliest fossil remains which have been discovered. Numerous volcanoes appear to have been active at this period, ejecting quantities of ashes, which, falling into the sea, entombed the animals living on its bed. Even at this early period there may be discovered indications of part of the sea's bed having been upheaved so as to form dry land or islands. Subsequently a depression took place, and an accumulation of sand was spread over the whole, constituting what is called the Caradoc Sandstone. After many thousands of feet of materials had thus been accumulated and become consolidated, another contortion and folding of the strata took place, followed by a change in the nature of the materials deposited in the sea. 2. The second series of deposits constitute the Old Red Sandstone, which consists mostly of detrital matter, but contains occasional beds of impure limestone (*cornstone*), and in its lower part there is a great thickness of marl, also coloured red by peroxide of iron, and occasionally streaked with blue and green, where the iron has been reduced to a lower state of oxidation by the presence of decomposing vegetable matter. The upper beds consist of coarse sand and gravel cemented together, and forming a hard conglomerate; the multitude of quartz pebbles, derived from *veins*, indicates an immense destruction of older rocks. No fossils are found in this formation, because sands are always barren, and peroxide of iron is fatal to animal life when it exists in excess; but in the *cornstones* a few remarkable fishes (*Cephalaspis*, &c.) have been obtained. These rocks appear to have been formed near a coast, whilst at a small distance in Cornwall and Devon the sea was depositing fine sediment, was free from the injurious peroxide, and abounded in organic life. The Old Red Sandstone is sometimes conformable to the underlying Silurian rocks,—at others unconformable; and in the Valley of the Towy it begins to overlap the Upper Silurian, and rest upon the Lower Silurian rocks; further west, it is itself overlapped by the coal-measures which there rest on the Silurians. 3. After this another great change took place, and the sea deposited carbonate of lime, forming the carboniferous limestone, well shown on the coast of Pembrokeshire. The lower part of this series consists of sandstones and shale, in which the remains of fishes occur in abundance. Mollusca also appear; and soon the abundance of organic remains becomes so great, that whole strata are formed of their remains: indeed, the carbonate of lime seems to have been chiefly procured by the agency of animal life. This limestone, which is sometimes 2,000 feet thick, dwindles to 70 or 80 feet towards Haverfordwest, and does not appear to have extended far to the north. Here a change of mineral character takes place in the coal-measures, originally consisting of mud, sand, gravel, and accumulations of vegetable matter. The lowest division, millstone grit or farewell rock, is usually a white quartzose sand, but sometimes a calcareous mudstone with organic remains, the equivalent of the culm of Devon. Above this were formed beds of mud and sand, with occasional beds of vegetable matter and carbonate of iron; these beds diminish in thickness from Merthyr Tydvil to Pont-y-pool; and are wanting in Dean Forest, but exist in the Bristol field. With respect to the origin of the coal in this district, there is evidence that it originated in accumulations of vegetable matter which *grew on the spot*. The conditions under which the beds of coal occur have been described minutely by Mr. Logan. Under each coal-seam is a bed of sandy clay, full of the fossil plants known as *Stigmariæ*, and which Mr. Binney has shown to be the roots of another plant, the *Sigillaria*, equally abundant in the coal, which must have grown in swamps near the sea. After each great accumulation of vegetable matter, the land seems to have subsided, and the sea flowed in, bringing sand and mud and marine shells; again marshes were formed, and fresh accumulation of peat and plants, to be in turn covered by silt from the sea. Evidence of the local origin of the coal is also afforded by the frequent occurrence of fossil trees with their trunks erect, and their roots spreading out in the clay below. Several of these trees, each 14 or 15 feet high, were discovered at the head of the Tawe Valley: the outside of their trunks appears to have been originally hard, and to have resisted the action of water for some time, but their interior was soft, and soon became hollow and filled with mud, which is regularly stratified: the sandstone on the outside of the trees also bears traces of the rippling of the water around them. The iron ore of the district occurs in the form of nodules of argillaceous ironstone, lying in courses; the cracks in those nodules being filled with carbonate of iron, just as those in the cement-stones (*Septaria*) of the lias are filled with carbonate of lime. Sometimes the iron ore is mixed with more or less carbonaceous matter, and is called black band. One of the remarkable phenomena of the coal district is the occurrence of cracks, attended with the displacement of the beds on either side; these *faults* are numerous, and amount in one instance to 2,400 feet: the cracks are sometimes wide, whilst at others the sides are in close contact. Many of the faults appear to have been formed before the deposit of the magnesian conglomerate; but others appear to have been formed at almost every subsequent period. In some instances beds of coal seem to have been partially washed away before the accumulation of the succeeding bed, giving rise to spurious faults, such as that called the "Horse" in the Forest of Dean. 4. At the conclusion of the coal period, all the existing rocks appear to have been squeezed and contorted; not only in Britain, but over a great part of Europe, a new deposit of detrital matter began to be formed, similar to those before the coal period, and called by way of distinction the *New* Red Sandstone. Where this formation approaches the older rocks it puts on the appearance of a shingle bed, in which the detritus of the older rocks is cemented together by carbonate of lime and magnesia, hence termed the magnesian conglomerate. These fossil beaches are thickest on the south-west and west flanks of the Mendip and other hills, indicating an open ocean and prevalent winds in that direction. In the red sandstone and marls formed at the same time, but further from the coast, there are no traces of animal life; but as the red stain disappears from the rocks, towards the conclusion of the period, remains of fishes and shells appear. 5. Further subsidences took place; the sea, now freed from the peroxide of iron, swarmed with animals of extraordinary form and structure. We still trace its boundaries in Glamorganshire and the Mendips by beds of rolled pebbles from the subjacent rocks, and close to these sheltering coasts the remains of marine saurians abound in the consolidated mud and limestone (*Lias*), along with the bones of the flying *Pterodactyle*. Somewhat later, great beds of oolitic limestone were accumulated in the

sea, which now constitute the Cotteswold hills, and their extension to Bath and Dorsetshire. 6. No further history is afforded by this district until comparatively modern times, when we find evidence of subsidence beneath the sea, and of agencies by which the present form of the surface was accomplished. The present land must have been at least 1,500 feet lower, and, therefore, nearly all under the sea. There is also evidence that the climate became cold, that there were glaciers in the mountains of North Wales, and icebergs floating round the shores, carrying blocks of stone and gravel, and presenting all the phenomena of Polar regions. The sea also accumulated beds of clay, in which the few existing shells are of Arctic character. Still later the land must have risen again above the sea to an elevation greater than it now has; for we find *submarine forests* fringing all the shores of Europe from Spain to Norway. Of this one of the best examples occurs in Swansea Bay, where the stumps of oak and alder may be seen at low water, 20 or 30 feet lower than they could have grown.

"On the Relative Position of the various Qualities of Coal in the South Wales Coal-field," by S. Benson, Esq.—The coal is of three kinds: 1. Bituminous, the small of which will coke; 2. Free-burning, the small of which will not coke, but which burns with great rapidity and a considerable volume of flame; 3. Anthracite, or stone coal. These three pass into one another imperceptibly; the same vein of coal changing gradually from bituminous to free-burning, and from this to anthracite. 1. The coal beds which crop out on the south side of the basin are highly bituminous, becoming less so towards the north. The five-foot vein, extensively worked near Swansea on the south rise, is highly bituminous,—on the north rise, within a distance of two miles, it becomes free-burning. The various beds also differ considerably in their bituminous qualities and commercial value. 2. The free-burning coals occupy a tract running north-east and south-west through the centre of the coal-field. Those which are intermediate between the free-burning and bituminous, are perhaps better adapted than any for smelting purposes,—and in the neighbourhood of Merthyr form the chief supply for the blast furnaces, being either used raw, or the large only being coked in the open air. The pure free-burning coals are less adapted for smelting, but are preferred for steamers from their readiness of combustion and the absence of clinkers in the grate. Free-burning coals are admitted to government contracts from the following places: Llangennech, Camerons, Graigola, Brindowey, Resolven, and Aberdare. 3. The northern side of the basin is occupied by the anthracite, which graduates through the various "culms" into the free-burning coal. In Pembrokeshire, the coal is all anthracitic. Taking the area of the Glamorganshire coal-field at 750 square miles, it is estimated that $\frac{1}{3}$ of this area is occupied by bituminous and free-burning coals, and the remainder by culm and anthracite. It appears that the beds of coal on the south crop lose their bituminous qualities gradually as they dip to the north; so that if, on a section, lines are drawn to show the boundaries of the qualities of coal, they will not be vertical, but inclined to the north. If the change in the quality of the coal is attributed to the influence of subterranean heat, then the inclination of these lines will serve to point out the direction from which that heat acted, namely, from the north-west of the coal-field.

"On a Boulder of Cannel Coal found in a vein of common Bituminous Coal," by S. Benson, Esq.

Mr. Booker, being called on by the President for some statistical information, stated that there were 159 blast furnaces in the district employed in smelting iron, and that 550,000 tons of iron were annually manufactured. The coal raised in the district was employed as follows:—

1,500,000	tons	annually in the manufacture of iron.		
200,000	"	"	"	copper.
150,000	"	"	"	tin.
750,000	"	employed in domestic purposes and in agriculture.		
1,750,000	"	exported.		
4,350,000	tons per annum.			

At this rate, and supposing the coal to exist only over 100 square miles, there was sufficient for 1,400 years to come. The value of the exports from the district, consisting of iron, &c., in a state of rough manufacture, amounted to £4,000,000 a-year.

"On Fossil Remains recently discovered in Bacon Hole, Gower; also some from beneath the Bed of the River Tawe," by C. S. Bate, Esq.—Bacon Hole is a fissure in the limestone rock on the sea-coast west of the headland of Poldy, and about nine miles from Swansea; it is about 20 feet above high-water mark, and narrows rapidly from the entrance to the extremity, where it divides into two fissures: it is 30 feet wide in the centre of the main chamber, and 128 feet long. The sea appears to have already removed part of it, as the shore below is strewn with masses of breccia and stalagmite. The floor is highest at the entrance, and inclines gradually inwards; the roof of the cave at the highest point does not exceed 12 feet, but the two fissures at the end rise to a much greater height. The fissure above the cavern is filled by a deposit of carbonate of lime, which, however, only forms one stalactite, the "flitch of bacon," from which the cavern takes its name; on the floor, the stalagmite is extremely thick, and requires to be blown up with gunpowder before the breccia below can be explored. In this have been discovered bones of the deer, ox, cave bear, hyena (?), and bat, and the seed of a plant; the cave does not, however, appear to have been inhabited as a den. Mr. Bate also exhibited antlers of the red deer from the clay about six feet below the bed of the river Tawe, discovered in digging the foundation for a bridge and other works.

The Dean of Westminster remarked that the entrance of the cave of Paviland, and others on this coast, had been washed away by the sea.

"On the Drainage of a Portion of Chat Moss," by G. W. Ormerod.—The *surface* of the moss varies from 80 feet to 100 feet above the sea level; its *bottom* at the deepest part is 100 feet below the sea line. Part of this moss is now being laid dry by means of open drains, under the directions of Mr. Ormerod. After cutting the drains, the level of the peat falls rapidly; near the main leader it sank perpendicularly 5 feet 6 inches in nine months, and in one part 2 feet 6 inches in a single week.

The Dean of Westminster inquired whether, after the peat had been burnt, a fertile soil could be obtained without the addition of lime and other materials, which usually cost as much as £20 per acre. In the borders of the Irish bogs many tracts had been reclaimed by small occupants, who worked upon them, and exercised a proper economy with regard to manures. But if large tracts of bog had to be reclaimed by landowners who had to pay for everything, it became a question of cost which had not been answered.—Mr. Ormerod replied that a considerable amount had been reclaimed on the borders of Chat Moss, and that the occupants were so well satisfied with the experiment that they were going on with it. It was usual, after taking the water off, to delve it, and apply town manure mixed with marl from the borders of the morass.

"On the Geology of Pennsylvania," by Professor Rogers.—Professor Rogers exhibited a General Map of North America, the State Survey of Pennsylvania, and many other maps and sections, coloured geologically. 1. After pointing out the general accordance in the succession of the older rocks in America with those of Europe, he stated that the rocks composing the great Apallachian chain had been deposited near the eastern shore of the Palæozoic sea in North America, and detailed a variety of circumstances in evidence of the existence of an ancient continent in the direction of the Atlantic. 2. Amongst these hills there is a well-defined series of rocks, containing a succession of fossils; but further west, where the same strata spread out to an enormous extent (in Kentucky and Tennessee), we seem to have arrived at the deep-sea part of these formations, in which all distinctions melt away, and a uniform succession of sedimentary deposits have accumulated to a much greater thickness than near the coast. Wherever the tributaries of the Ohio, or the rivers of Virginia, break through the hills, we find beds of grit diagonally stratified, with conglomerate and all other indications of a shallow sea; but passing westward the same beds become finer and finer, the conglomerate passing into grit, and these into fine-grained sandstones. The carboniferous limestone, which is but a few feet thick in the Apallachian, becomes 500 feet thick on the Mississippi. 3. After the elevation of the greater part of this region, the sea still covered the whole of Florida, the great plains of Arkansas, and extended far up the Missouri, and along the Atlantic plain as far as New Jersey. Over this area was deposited first the cretaceous series, and afterwards the tertiary. 4. Between the tertiary plain and the Apallachian hills, is a great tract of unfossiliferous rocks (azoic and metamorphic), at least 10,000 feet in thickness, and along their western boundary for 100 or 150 miles the *newer rocks all dip under them*; this extraordinary circumstance was first explained by Professor Rogers, who has shown that it is the result of the folding of the rocks. The Apallachian chain consists, in fact, of a series of parallel anticlinal and synclinal folds, all leaning over to the west, so much as to *invert* the series of beds on the west of each synclinal: these folds are steepest where they plunge beneath the azoic series, and open out gradually westward, until the strata become horizontal in the Ohio coal-field. Professor Rogers then gave a summary of his theory of the origin of these great parallel foldings in the Apallachian strata, which he attributes to a series of earthquake movements flowing forward in a particular direction in parallel lines; and he illustrated this view by a description of three remarkable earthquakes in the year 1833. The first, that of St. Domingo, was experienced by the officers of a British vessel at sea, who stated that, looking at the coast, they had seen "the crests of the hills waving like the back of a serpent in gentle motion." These undulations had been traced along lines on which they were synchronous. The second, the earthquake in the vale of the Mississippi, in which the lines of synchronous shock ranged N.N.E. and S.S.W. for 500 miles: at a parallel 300 miles east of the first, the shock was experienced eight minutes later; and all along the Atlantic shore twenty minutes later; the sensation was not that of a harsh grating of subjacent rocks, but a billowy heave. Third, a few months later another earthquake affected the whole volcanic line of the Windward Isles and Bermuda simultaneously, and was attended by a sudden return to activity of some of the dormant craters; in the course of twenty-two minutes it had flowed to the United States, and rocked the whole coast from Florida to New York. All these phenomena were considered to prove the doctrine of a flexible crust, resting on a fluid nucleus; and as in former times the crust may have been more flexible, and the volcanic forces more energetic, the whole surface may have been thrown into billowy undulations, and these have become permanently fixed by the successive injection of lava into the cracks and fissures of the various folds, thus preventing their return to horizontality. 5. The three great coal-fields of America are—the Ohio, 740 miles long and 180 wide, covering an area of 60,000 square miles, a surface greater than that of England and Wales; the Illinois coal-field, covering 50,000 square miles; and the Michigan, occupying 15,000 square miles. Besides these, there are numerous anthracitic basins in Pennsylvania and Virginia; the farthest being 100 miles S.E. of the margin of the Ohio coal-field. In passing across these coal-fields, there is a gradual diminution in the quantity of bituminous matter from W. to E. In the Illinois it amounts to 40 or 45 per cent.; in Western Ohio, from 35 to 40; in Eastern Ohio, 25 to 30; in the table-land of the Alleghanies it is reduced to 18 or 20 per cent.; in a little coal-field, 20 miles E. of the great field, it is only 14 or 15 per cent.; in the western edge of the anthracite field 10 or 12 per cent.; and in the great body of the anthracite only 1 or 2 per cent. of gaseous matter exist, and this not in the form of bitumen. Farther south, in Kentucky and Tennessee, the same change takes place, and the associated rocks become metamorphic eastwards. All the coal, of every kind, rests on the same basis of rock, with the same fossils distributed through it, and the particular coal-beds can be identified even when separated by an interval of 50 miles. The anthracite field is 5,000 feet deep, and contains 50 seams of coal; the bituminous

coal-field of Ohio is 2,800 feet deep. The working of these coal-fields is increasing rapidly; 3,000,000 tons of anthracite, and 1,000,000 tons of bituminous coal are annually raised; and 700,000 tons of iron manufactured. A process for smelting iron ore with anthracite was long wanted, and the government of Pennsylvania had offered a premium for such a discovery. This was first achieved by Mr. Craig, in South Wales, by whom a patent was obtained in England; and for the use of it in America one ironmaster guaranteed him a preminm on all the ore smelted,—but, from want of an international patent-right, the process was soon imitated, and in some cases improved upon, by other parties in America.—Drawings were exhibited of the anthracite coal-mines on the Lehigh River, Pennsylvania, which are worked like an open quarry on the slope of a mountain rising 900 feet above the river; the coal is 60 feet thick, and surrounds the quarry in black glistening walls, capped by 40 feet of yellow sandstone; it is conveyed by a self-acting railway for eight miles down a declivity of from 100 to 140 feet per mile; the whole cost of obtaining it being 2*d.* a ton. This great bed of coal splits up into a number of divisions when quarried at some distance. 6. Professor Rogers then alluded to the subject of the drift, which had received new interest in America from the visit of M. Agassiz. This deposit is spread over the whole of the States, and extends westward to the Upper Missouri; where it rests upon the older strata its *floor* is worn, and striated with furrows, which follow the pre-established contour of the surface, diverging when they meet any obstacle, and coalescing on the further side; their general direction is N. and S. This drift is strewed indiscriminately over all the high ground as well as the valleys; neither the White Mountains in New York, 6,000 feet high, nor those between Lake Champlain and the St. Lawrence, 5,000 or 6,000 feet high, being centres from which the drift was dispersed. Besides this general drift with its boulders, there are long trains of angular masses of rock, running N. by W. and S. by E., on the borders of New York and Massachusetts, derived from great ragged chasms in the summits of the Alleghanies, 1,000 feet above the plain. These angular blocks rest upon the surface of the drift, which overspreads the country to the depth of 20 or 30 feet. They vary in size from that of a hogshead to a small house, one of them being 50 feet long, and they do not much diminish in size from N. to S. One of these trains has been traced to a distance of 50 miles; another parallel line at a distance of half a mile is 20 miles long, and there are various others: they are about 200 yards wide, and the blocks are not in contact, but lie a little apart. They are not strewed like *moraines* along the flanks of hills, but pass alike over mountain and valley, climbing summits higher than that from which they originated.

Mr. A. Petermann exhibited a new Hydrographic Map of the British Isles, on which about 1,550 rivers are distinguished by names, 480 lakes and ponds, and 40 waterfalls; the canals with their altitude, as well as that of the rivers and lakes, and the great drains in the fen districts. It was stated that there were 20 rivers in England, 10 in Scotland, and 10 in Ireland, each draining 500 square miles and upwards. Of these—

18	drain an area each =	500 to 1,000	square miles.
14	,, =	1,000 to 2,000	,,
8	,, =	2,000 to 10,000	,,

These last eight are—The

Humber (including Trent and Ouse) to Spurn Point	9,550
Severn (to Flat Holmes)	8,580
Shannon (to Loop Head and Kerry Head)	6,946
Thames (including Medway) to Nore Light	6,160
Barrow	3,410
Great Ouse	2,960
Bann	2,345
Tay, as far as Rhynd	2,250

The River Amazon drains a tract of 2,275,000 square miles.

Section F.—Statistics.

President—Mr. H. Vivian.

Vice-Presidents—Sir C. Lemon, Mr. T. Tooke, Lieut.-Col. W. H. Sykes.

Secretaries—Mr. J. Fletcher, Capt. R. Shortrede.

"Facts bearing on the Progress of the Railway System," by Mr. W. Harding.—The modern railway system of Europe may be said to date from 1830, when the construction, by Mr. G. Stephenson, of the Liverpool and Manchester Railway, with its locomotive engines, was completed. After that date we heard no more of such prophecies as the following (from the *Quarterly Review*, in 1825), which it is not useless to record as a lesson of caution to us for the future:—"As to those persons who speculate on making railways generally throughout the kingdom, and superseding all the canals, all the waggons, mails and stage-coaches, post-chaises, and, in short, every other mode of conveyance by land and by water, we deem them and their visionary schemes unworthy of notice. What, for instance, can be more *palpably absurd and ridiculous* than the following paragraph,"—in which a prospect is held out of locomotives travelling twice as fast as stage-coaches. "We should as soon," adds the reviewer, "expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's ricochet rockets, as trust themselves to the mercy of such a machine, going at such a rate." The modern railway system has, however, not only done this, but it has given rise to new habits in the present generation, and has proved to be the great mechanical invention of the nineteenth century, as the steam-engine was of the eighteenth. As it is still in its infancy, it is especially the province of statistical inquiry to watch its growth, so that, on the one hand, timely remedies may be applied to its defects, and, on the other, free scope may be given to its beneficial tendencies. Valuable papers have been contributed by Messrs. Laing, Porter, Graham, and others, analyzing the traffic on railways during the infancy of the system to the year 1843. Shortly before that period there had been a pause in railways. During two years only five miles had been sanctioned, but the period which has since elapsed comprises the memorable mania years of 1845 and 1846. Under this excitement, intelligence and emulation have been stimulated among the managers of railways to the utmost, and the system has rapidly advanced. The consolidation of lines under a few great companies, by the process styled amalgamation, has proceeded;—the atmospheric, an entirely new system of traction, has been brought forward;—the electric telegraph, conveying intelligence at the rate of 280,000 miles a second, has been widely introduced;—express trains, travelling at nearly the highest attainable speeds, have been established,—and the length of railways in operation has been doubled. It therefore becomes a matter of interest to inquire, to what the results of so active a period point. Have low fares answered?—Has the third-class traffic, the most important to the bulk of the people, been encouraged, and has it been found wise, not only for the users but for the owners of railways, to encourage it or the reverse?—Has the increase of speed been successful, and are we likely to travel faster or slower hereafter?—How have the receipts kept up while the length of railway has been doubled?—Did the first 2,000 miles get the cream of the traffic, as has often been thought, and has the average receipt per mile consequently fallen off?—Should the experience of the past, in short, give us confidence in urging on the system at the extraordinary rate in which we are now doing it, or not? In the following investigation and collection of facts it has been attempted to throw some light upon these points—the recent publication of the official railway returns for 1846 and 1847 affording peculiar facilities for the purpose. The following paper refers to English, Scotch, and Welsh lines only,—the Irish lines are excluded, the economical condition of Ireland being different from that of this country, and there being but few railways open in that country:—

Comparative Lengths of Railway open in 1843 *and* 1847, *and Receipts thereon.*

The lengths of English, Scotch, and Welsh railways, open June 1843, were	1,990
Ditto, open at the commencement of 1848	3,597
The gross receipts returned for the year 1842, were	£4,740,000
Ditto for the year ending June 30, 1847	8,326,772

After making the necessary corrections in the above figures, the average receipts per mile of railways in 1842, were £2,489; in 1847, £2,596. We therefore arrive at the important fact, that, although the mileage of our lines has been doubled, the receipts have been more than doubled. This must be regarded as a favourable general feature in the state of railways. There was much reason to fear that, as the first railways ran between the great towns or traversed the manufacturing districts, the railways which were next opened would show a great falling off in receipts. Hitherto, then, we find that this is not so,—a fact which may give us confidence as regards the great length of railway which has been sanctioned by Parliament, but which is not yet open.

Lines sanctioned but not open.—The length of railway sanctioned by Parliament at the commencement of 1848, but not then open, was 7,150 miles. A considerable portion of this is in progress, more or less rapid. On the 1st of May, 1847, 5,209 miles were returned as in progress, on which 218,792 persons were employed, or 42 per mile.* These new railways are principally designed for the accommodation of the agricultural parts of the country. We will presently refer to the prospects of railways in such districts. When the railways now in contemplation are completed, and it is probable that the greater portion will be so in the course of the next five years, we shall have upwards of 10,000 miles of railway open,—on which, judging from the numbers employed on lines now open* (viz. 14 per mile), 140,000 persons will be permanently employed, at good wages,—representing, at five to a family, three-quarters of a million of the gross population. The importance of this addition to our internal communications will be appreciated when it is remembered, that there are only about 4,000 miles of inland navigation, and 30,000 miles of turnpike road, open for traffic in the country.

Analysis of Traffic.—General Features.—The gross traffic for the year ending June 30, 1847, was, as we have seen, £8,366,000. There were conveyed during that year, from the returns of the Board of Trade,† in round numbers, 7,000,000 tons of merchandise and goods, 8,000,000 tons of coal, 500,000 horned cattle, 1,500,000 sheep, and 100,000 horses.

Of the gross sum, £8,366,000, the passenger receipts were	£5,024,000
The receipts from all other sources—goods, cattle, carriages, parcels, mails, &c.	3,342,000
	£8,366,000

In every £100 of receipts, the passenger traffic therefore forms 60 per cent., the traffic receipt from other sources 40. In 1842, these proportions were as 64 to 36. The proportions of traffic receipts from other sources than passengers (being principally goods and cattle traffic) have thus increased since 1842 as 40 to 36, or 11 per cent. The total number of passengers carried in the year (ending June 30) 1847, was 47,484,134, as compared with, in 1842, 22,403,478. The average distance travelled by each passenger was, in 1842, 13 miles; in 1847, it was 16 miles. The numbers and proportions of classes were—

	In 1847.	In 1842.
First class	14·2	20·2
Second class	38·3	45·4
Third class	47·5	34·4

* In this return, the number of miles returned as in progress are more than those really in construction, the number of men employed per mile is less than the truth.

† These returns are not complete, and they require some correction, in respect of the same articles being sometimes conveyed over several different lines, and therefore counted over more than once.

Thus, the third-class passengers (which have increased in number since 1842, from 6,000,000 annually to 21,000,000) now form nearly half of the whole number travelling, whereas in 1842 they formed only about one-third. Only one-third of the third-class passengers have availed themselves of the parliamentary trains arbitrarily (and, as it appears to me, unfairly) imposed upon railway companies in 1844. The following table, comparing the fares of the metropolitan railways in the year ending June, 1843, with those in the year ending June, 1847, shows the great reduction which has taken place in fares during the last four years. To make the comparison more appreciable, the fares are taken as for 100 miles in pence.

Railway.	Fare for 100 Miles.					
	1st Class.		2nd Class.		3rd Class.	
	1843.	1847.	1843.	1847.	1843.	1847.
London and North-Western	334·8	218·1	241·1	144·6	131·2	93·3
Great Western	303·1	274·4	208·5	187·8	118·3	100·0
London and South-Western	312·0	245·0	210·0	168·0	120.0	96·0
Eastern Counties	294·1	210·0	227·4	141·5	164·7	92·3
Northern and Eastern	217·4	—	165·5	—	110·9	—
South-Eastern	227·0	214·0	150·0	152·0	87·5	90·0
London and Brighton	350·0	263·0	225·0	171·0	150·0	109·0
Average	303·5	237·4	210·3	160·8	128·6	96·7
Difference per cent.	—	21·8	—	23·8	—	25·0

This reduction in fares, coupled with the increase in the number of trains, and the speed of travelling, must be regarded as the principal cause of the great increase of the number of passengers since 1843.

We have already seen that the numbers in 1847 and 1843 are as 47,484,134 to 22,403,478. If we take into account the number of miles opened at those dates respectively, the annual number per mile was, in 1842, 11,772, and in 1847, 14,806.

The proportion of third-class passengers has, we have seen, thus satisfactorily increased between 1842 and 1847. The third-class traffic has, however, developed itself very differently on different lines; and it may be well to inquire into this. The statement subjoined shows the third-class traffic of two metropolitan companies (the Eastern Counties and the Great Western)—two North of England companies (the Lancashire and Yorkshire, and the Newcastle and Berwick)—and two Scotch companies (the Edinburgh and Glasgow, and the Glasgow and Greenock.)

Year ending June 30, 1847.

Name of Railway.	Length in Miles.	Number of Third-class Passengers conveyed.	Proportion in every Hundred of Third-class Passengers.
Glasgow, Paisley, and Greenock	23	957,534	83·3
Newcastle and Berwick	65¼	944,891	79·5
Edinburgh and Glasgow	46	836,025	72·8
Lancashire and Yorkshire	109	2,090,624	72·3
Midland	285	2,366,892	65·4
Eastern Counties	177	1,044,158	50·3
Great Western	240¾	419,663	14·6

From this it appears, that while the Great Western Company, on a line 241 miles long, have only carried 419,663, the Edinburgh and Glasgow Company, on a line 46 miles long, have carried 836,025; the Midland Company, 285 miles long, 2,366,892; and that while on the Great Western only 15 out of every 100 passengers conveyed are third-class, on the Eastern Counties 50 out of every 100, and on the Glasgow, Paisley, and Greenock, 83 out of every 100 are third-class passengers. Although it is true that the different character of the population and other circumstances will affect to some extent the relative number of third-class passengers on different lines, the disparity here is so great, that we can come to no other conclusion than that the arrangements of such a line as the Great Western, as to third-class passengers, must be such as to preclude hundreds of thousands of third-class passengers yearly from using the railway, who, with greater facilities, would be glad to use it. I say this with confidence, because, as manager of the Glasgow and Greenock Railway, where the third-class system has been more developed than on any line in the country (and where we carried passengers at a profit for one farthing a mile), I had an opportunity of observing the real advantage and comfort which very cheap travelling is to the working class. As the results of the working of that line afforded a remarkable instance of the effects of low fares, I have thought that it might not be uninteresting to record them. The River Clyde runs beside the Glasgow, Paisley, and Greenock Railway, which is 23 miles long. The steamboats have long afforded an excellent mode of transport between Glasgow and Greenock, the fares by boat before the railway opened being from 1*s.* to 2*s.*, and the time occupied was about two hours. Glasgow, with a population of 274,000, was at one end of the line, Greenock, with a population of 36,000, at the other end of the line, and various summer watering-places lie at the mouth of the Clyde, below Greenock. On the line were Paisley (population 60,000) and Port-Glasgow (population 7,000). Between Glasgow and Paisley was a canal, on which there were passenger-boats drawn by horses at a speed of 6 miles per hour. These facilities gave rise to a great traffic before the railway was opened,—the yearly number travelling along the course of the railway being 1,185,340, and the average fare 1*s.* 4*d.* Notwithstanding this, after the railway was opened (in 1843), the numbers travelling by all means of conveyance were found to exceed 2,000,000, or to have increased 100 per cent., the average fare having in the meantime fallen to 10*d.* This was the gross result; but the fares of the railway (originally 2*s.* 6*d.* first-class, and 1*s.* 6*d.* second-class, for 23 miles) were varied from time to time; and as I closely observed the effects of these variations, having caused an account to be taken of the number travelling by steamboat and canal as well as by railway, it may be well to state the results of these variations of fares.

MONTHLY NOTES.

On the Notation of Time.—Mr. Alfred Novello has addressed a letter to the *Athenæum*, on the subject of the reformation of our present system of notation of time, offering a sound practical suggestion for the more ready statement and comprehension of the hours. He says,—"It has long appeared to me that it would be very convenient to number the hours of the day from 1 to 24, beginning at midnight; as the additional words, "morning," "afternoon," "evening," "A.M.," and "P.M.," at present essential to specify the time, might be dispensed with, and we should then have a distinct name for each hour in a day. This is becoming more necessary to the proper understanding of railway time-bills, especially for the long lines. The proposed numbering would take no extra room in any tables,—as four figures are already required for the hours and their fractions. No difficulty would occur even with the clocks, which could easily have the additional figures placed in an outer or inner circle on the face. In England, I think this change would find universal adoption if two establishments would agree to adopt it—I mean the post-office and the railways. The announcement, 'The packet sails Sept. 16 at 14 o'clock,' would completely explain the time,—instead of saying 2 o'clock in the afternoon." Like the Decimal Coinage, the adoption of this plan would at first cause some annoyance; but we are persuaded that it would, when understood, save time, and economize our expressive powers.

The Prevention of Oscillation of Railway Carriages.—We have had laid before us a Report of the Committee of the Royal Scottish Society of Arts, on a "Method of Preventing the Oscillation of Railway Carriages," by Mr. Andrew Mennie of Forfar. The apparatus consists of two transverse shafts, placed, the one near the end of the carriage, the other near the centre, and fitted with bell-cranks on their extremities, which cranks are connected by longitudinal bars passing along the sides of the carriage. The bearings for the bell-crank shafts, and the carriage-wheel bearings, are all connected with the longitudinal bars. The inference is, that with such an arrangement, springs of greater elasticity than those at present in use, might be employed without disarranging the equilibrium of the vehicle. As an example of the theory of the scheme, if we suppose a person to stand upon a gig-step, his weight would be equal on both springs, and therefore the seat would not be thrown out of level. It would be difficult, without a diagram, to explain the action of the couplings; but it appears, as indeed the committee before mentioned has reported, that the vertical, only, and not the lateral oscillation would be counteracted; and it is questionable whether, indeed, the rigidity of the bars would not overrun the object in view, and injure the action of the springs. At present we have in some cases too much spring motion; with Mr. Mennie's plan in operation, we fear we should have too little.

ENGLISH PATENTS.

Sealed from 14th September, 1848, to 19th October, 1848.

Robert Walter Winfield, Birmingham, merchant and manufacturer, and John Ward, Birmingham, aforesaid, a workman in the employ of the said Robert Walter Winfield,—"Certain improvements in the manufacture of tubes, and in the manufacture of certain articles made in part of tubes."—September 14th.

William Sager, Rochdale, wool dealer,—"Certain improved means and apparatus for effecting the transit or conveyance of goods, passengers, and correspondence, by land or water, and for other such purposes; part or parts of which means and apparatus constitute a new and improved method of generating steam, which improvement is applicable to other purposes to which steam is generally applied as a motive power."—15th.

Joseph Lillie, Manchester, engineer,—"Certain machinery or apparatus applicable for purifying and cooling liquids, and for purifying, condensing, and cooling gases."—21st.

John Frearson, Birmingham, machinist,—"Improvements in bending or shaping iron or steel, and other metals."—21st.

Henry Wilson, foreman to Messrs. William Greaves and Son, Sheaf Works, Sheffield,—"Improvements in the manufacture of chisels and gouges."—21st.

William Brown Roof, Stanhope-street, Regent's-park, chemist,—"Certain improvements in the construction of respirators."—21st.

Robert Stirling Newall, Gateshead, Durham,—"Improvements in locks and springs, and in the means of fastening and setting up the rigging of ships."—28th.

Andrew Paton Halliday, Manchester, manufacturing chemist,—"Certain improvements in the manufacture of pyroligneous acid."—28th.

Fennell Allman, Charles-street, St. James's-square, Westminster, consulting engineer,—"Certain improvements in apparatus for the production of light from electricity."—28th.

William Wilkinson Nicholson, Acton-street, Gray's-inn-road, civil engineer,—"Improvements in machinery for compressing wood, and other materials requiring such a process."—28th.

Joseph Gillott and John Morrison, Birmingham,—"Improvements in ornamenting cylindrical and other surfaces of wood and other material."—28th.

Thomas Metcalfe, High-street, Camden Town, Middlesex, gentleman,—"Improvements in the construction of chairs, sofas, and other articles of furniture for sitting or reclining on."—October 5th.

Edward John Massey, Liverpool,—"Improvements in apparatus for measuring the speed of vessels and streams, and for ascertaining the depths of water."—5th.

Joseph Sharp Bailey, Bradford, York, spinner,—"Certain improvements in preparing, combing, and drawing wool, alpaca, mohair, and other fibrous materials."—5th.

Elias Robison Handcock, 16 Regent-street, London, and Rathmoyle House, Queen's County, Ireland, Esq.,—"Certain improvements in mechanism applicable to impelling and facilitating the propulsion of vessels in the water, which improvements are applicable to locomotive engines for railways and other similar purposes."—12th.

John Ashby, Carshalton, Surrey, miller,—"Certain improvements in machinery applicable to cleaning grain and dressing meal."—October 12th.

Daniel Watney, Wandsworth, Surrey, distiller, and John James Wentworth, of the same place,—"Improvements in machinery for drilling metals and other substances."—12th

John Wright, Camberwell, Surrey, engineer,—"Improvements in generating steam and evaporating fluids."—12th.

Charles de Bergue, Arthur-street West, London, engineer,—"Improvements in bridges, girders, and beams."—12th.

Arthur Dunn, Dalston, chemist,—"Improvements in ascertaining and indicating the temperature and pressure of fluids."—12th.

John Davie Morris Sterling, Black Grange, N.B., Esq.,—"Improvements in the manufacture of iron and metallic compounds."—12th.

Samuel Cunliffe Lister, Manningham, Yorkshire, gentleman,—"Improvements in preparing, heckling, and combing wool and other fibrous substances."—19th.

Frank Clarke Hills, Deptford, Kent, manufacturing chemist,—"Improvements in treating certain salts and gases or vapours."—19th.

Robert Angus Smith, Manchester,—"Improvements in the application and preparation of coal tar."—19th.

Robert William Sievier, Upper Holloway, Middlesex, gentleman,—"Improvements in the means of warping and weaving plain and figured fabrics."—19th.

Joseph Eugene Asaert, Lille, in the republic of France, machinist,—"Improved means of obtaining motive power."—19th.

SCOTCH PATENTS.

Sealed from 26th September, 1848, to 13th October, 1848.

Robert Thomson Pattison, Glasgow, Scotland, printer,—"An improved preparation or material for fixing paint or pigment colours on cotton, linen, woollen, silk, and other woven fabrics."—September 26th.

William Southam, Nuneaton, Warwickshire,—"Improvements in corn mills, or in machinery for pulverizing corn, grain, or seeds."—26th.

William Losh, Newcastle-upon-Tyne,—"Improvements in steam-engines."—26th.

James Petrie, Rochdale, Lancashire, engineer,—"Certain improvements in steam-engines."—26th.

Thomas Spencer, Prescot, Lancashire, earthenware manufacturer,—"Certain improvements in machinery or apparatus for manufacturing pipes or tubes from clay or other plastic materials, part or parts of which improvements are applicable to the manufacture of hollow earthenware."—27th.

John Davie Morris Sterling, Black Grange, N. B., Esq.,—"Improvements in the manufacture of iron and metallic compounds."—October 2d.

George Royce, Fletland, Lincolnshire, miller,—"Improvements in machinery or apparatus for depositing, cleansing, and grinding corn and seed; also, in apparatus for dressing the meal or flour made from wheat and other grain."—2d.

William Sager, Rochdale, Lancashire, wool dealer,—"Certain improved means and apparatus for effecting the transit or conveyance of goods, passengers, and correspondence, by land or water, and for other such purposes; part or parts of which means and apparatus constitute a new and improved method of generating steam, which improvement is applicable to other purposes to which steam is generally applied as a motive power."—3d.

Richard Coad, Kennington, Surrey, chemist,—"Improvements in the construction of fuel, and in applying the heat so obtained."—6th.

Andrew Paton Halliday, Manchester, manufacturing chemist,—"Certain improvements in the manufacture of pyroligneous acid."—10th.

William Wilkinson Nicholson, Aetou-street, Gray's-inn-road, Middlesex, civil engineer,—"Improvements in machinery for compressing wood, and other materials requiring such a process."—10th.

Alonzo Buonaparte Woodcock, Manchester,—"Improvements in steam-engines, and in apparatus for raising, forcing, and conveying water and other fluids."—13th.

IRISH PATENTS.

Sealed from 20th September, 1848, to 20th October, 1848.

William Southam, Nuneaton, Warwickshire, miller,—"Improvements in corn mills, or in machinery for pulverizing corn and other grain or seeds."—October 4th.

Thomas Marsden, Salford, Lancashire, machine maker,—"Improvements in machinery for dressing or combing flax, wool, and other fibrous substances."—11th.

John Scaffern, Upper Holloway, M.B.,—"Improvements in the manufacture and refining of sugar."—11th.

Charles Low, Dalston, Middlesex, gentleman,—"Improvements in the manufacture of copper."—14th

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 14th September, 1848, to 18th October, 1848.

Sept. 14th,	No. 1586.	Francis Pastorelli, Cross-street, Hatton Garden,—"Wheel barometer."
—	1587.	Elizabeth Middleton, and Margaret Rettie, London,—"Sanatory urinal, or air trap, for preventing effluvia."
16th,	1588.	John Brockliss, Castle Mills, Oxford,—"Brush for dressing flour."
—	1589.	Frederick Walton and Co., Old Hall Works, Wolverhampton,—"Torricellian shower-bath."
19th,	1590.	Ephraim Smith, Carlisle-street, Soho,—"Spring swivel or hook."
21st,	1591.	Hammond, Turner, and Sons, Birmingham,—"Eye (hook and eye)."
22d,	1592.	Francis Mordan, 6 Goswell-road,—"Adjusting everlasting gold pen."
—	1593.	Samuel Horwood Park, Kingswood, Gloucestershire,—"Nut key or spanner."
25th,	1594.	Thomas Hunt, Preston,—"Metallic packed gland."
26th,	1595.	Frederick Marsh and Co., Castle-street East, Oxford-street,—"Oriental shower-bath."
27th,	1596.	Stephen Peile Babington, George-street, Hanover-square,—"Hat peg or support."
29th,	1597.	William Rowan, Belfast, engineer,—"Fluctuating slider."
30th,	1598.	James Moor Martin, Walworth,—"Protector, or railway travelling cap."
—	1599.	Alfred Augustus de Reginald Hely, Manchester-buildings, Westminster,—"Portable gaseous liquid fountain."
Oct. 2d,	1600.	George Chambers and Co., Studley,—"Holder for crotchets or tambour needle, a picreer, or other similar articles."
Oct. 2d,	1601.	Thomas Rontree, and A Brown, Liverpool,—"Improvements in stand and other pipes used for the conveyance of fluids."
4th,	1602.	Prosper Alex. Lambert, Bedford-street, Covent-garden,—"Improvements in the shape or configuration of mechanical or artificial leeches, and the lancets used therewith."
5th,	1603.	George Fred. Morrell, Fleet-street,—"Abutments applicable to all arches and brestsummers."
6th,	1604.	John Coney, Birmingham,—"Instrument for crotchet and tambour work."
—	1605.	Henry M'Groy, Birmingham,—"Eye (hook and eye)."
—	1606.	Thomas Walley, Salford,—"Portable stamp and label affixer."
7th,	1607.	H. Crosley, Son, and Galsworthy, Southwark, engineers,—"Gas exhauster."
—	1608.	Harrild and Sons, Great Distaff-lane, and Friday-street,—"Printing apparatus."
—	1609.	David Walsh, Glasgow,—"Fork for weft protector."
9th,	1610.	Thomas Drew, Plymouth, chemist,—"Sanatory belt and cholera repellant."
10th,	1611.	Ralph Wedgwood, Rathbone-place and Lombard-street,—"Clip desk."
—	1612.	Robert Bedington, Birmingham,—"Knob for latches and catches."
—	1613.	E. M. Handford, Hathern, near Loughborough,—"Double-acting draught tackle."
11th,	1614.	Alfred Wilson, Percival-street, Clerkenwell,—"A pair of silent shears."
12th,	1615.	Joseph Tyler and Son, Warwick-lane, Newgate-street,—"Water-closet valve."
—	1616.	Richard Brotherton, Preston,—"Railway safety signal telegraph."
13th,	1617.	James Marr, John Gallie, and Co., London, Edinburgh, and Dublin,—"Script type."
—	1618.	Welch and Margetson, Cheapside,—"A Poncho wrapper."
14th,	1619.	G. F. Bowers, Brownhills, Staffordshire, Thomas Betteney, Longton, Staffordshire, and Edward Challiner, Tunstall, Staffordshire, —"Magnetic slips and glaze troughs."
16th,	1620.	J. Presland, Charlotte-street, Blackfriars-road,—"Hatband."
17th,	1621.	Alex. Chaplin, Limehouse,—"Smiths' portable furnace."
—	1622.	George Fitt, Bishopsgate,—"Package for lard."
—	1623.	William Middleton, Birmingham,—"Springs for buffers and drawbars of railway carriages."
18th,	1624.	John and James M'Rae, Ave Maria-lane,—"Inkstand."
—	1625.	W. and T. Avery, Birmingham,—"Weighing machine."
—	1626.	Capper and Waters, Regent-street,—"Tasca collar."

TO READERS AND CORRESPONDENTS.

R. M. S., Kilmallock.—It is simply a question of frictional surface—we should prefer cranks. We do not see any objection to this manner of driving, except that in starting the driven spindle may catch on the centre.

H. W. Harper, Manchester.—We have endeavoured to procure the drawing, but have not succeeded up to this date; possibly we may yet get it. For his general remarks we are obliged.

R. M.—His expansion motion for stationary engines appears to be nothing more than the ordinary link motion with a *straight link*. He will excuse us for remarking, that the action of the rectilineal link would derange the action of the valve, inasmuch as the alteration of the position of the adjusting nut, in changing the degree of expansion, would make a considerable difference in the relation originally subsisting between the valve and the cylinder ports. The curved link provides for this movement, as he will easily see upon examination. The plan has been applied by Rennie, Nasmyth, and others, to marine and stationary engines.

A. Sparke, Devonport.—Does he mean to insinuate that we should give him a premium for permission to publish the process in our pages? As an account of it has been read before the R. S. S. A. in open meeting, we cannot but applaud his desire to keep it secret now.

Mr. Davies.—He should have heard from us earlier had we not neglected to copy his address. Will he oblige us with it again, and the pamphlet will be sent by return of post.

A Constant Subscriber, London.—We have repeatedly answered this query. He may purchase tracing paper cheaper than he can make it to advantage; but any Cyclopedia will give him the required information.

D. M. A., Glasgow.—The series of papers on light will shortly supply him with an essay on the Daguerrotype and Photography. He appears to confound the two processes; prepared paper is not used in the daguerrotype system, which refers solely to the production of images on metallic surfaces. Every process of this nature is, of course, a member of the photographic family, the name Daguerreotype resulting merely from the discoverer of the process. The description will appear almost immediately.

J. Brewerton, Wakefield.—This is a popular mechanical error. If he had ever applied the indicator to a good air-pump, he would have found that the vacuum does not vary between the up and down stroke of the bucket. Double-acting pumps have been tried, but have not been found economical in practice.

T. Ford, London.—The difference of the *moving pressures* is, of course, the true amount; the difference of capacity is not the proper expression, as it must refer to the area, pressure, and length of stroke, constituting what may be termed the moving pressure or labouring force.

James Taylor, Carlisle.—We have attended to his request. We wait the particulars.

J. Kennedy, Cork.—Has he got our dispatches? We shall be glad to hear further from him.

S. S., Stamford.—The whole details were reversed, therefore they bear the same relation to each other as before. The drawing will be acceptable.

J. Robertson, Glasgow.—We have received nothing further from him. Is the apparatus completed?

D. E., Edinburgh.—Did our note reach him? He will see that articles of this class are being considerably improved just now; and great activity prevails amongst the manufacturers.

J. Brook, Leeds.—His two problematical queries will hardly require a Newton for their solution. The first is nothing more than a simple calculation of area, varied a little by the peculiarities in the construction of the boiler and furnace; whilst the second is to be seen in any geometrical school-book.

J. C., London.—We shall be glad to have the drawings transmitted direct here.

J. M., Westonbury.—Not having received any explanation of his drawings, we have not been able to make any use of them up to the present date. Are we to have the desired particulars supplied?

A. Walker, Cheltenham.—The due supply of practical information can only be effected on the principle of mutual accommodation. Let him, for example, favour us with some of his own experiences.

Mr. Taylor, Preston.—We will endeavour to furnish some information on the subject next month.

Mr. Cubr.—Next month.

ADAMS' LOCOMOTIVE-CARRIAGE FOR BRANCH TRAFFIC.

Fig. 1.

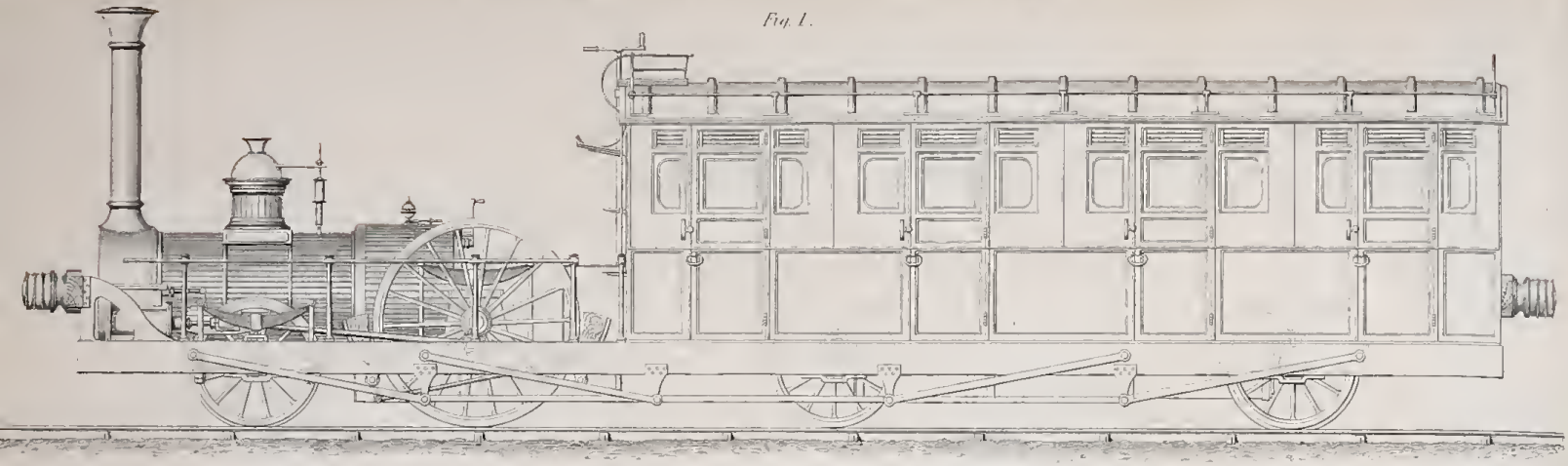
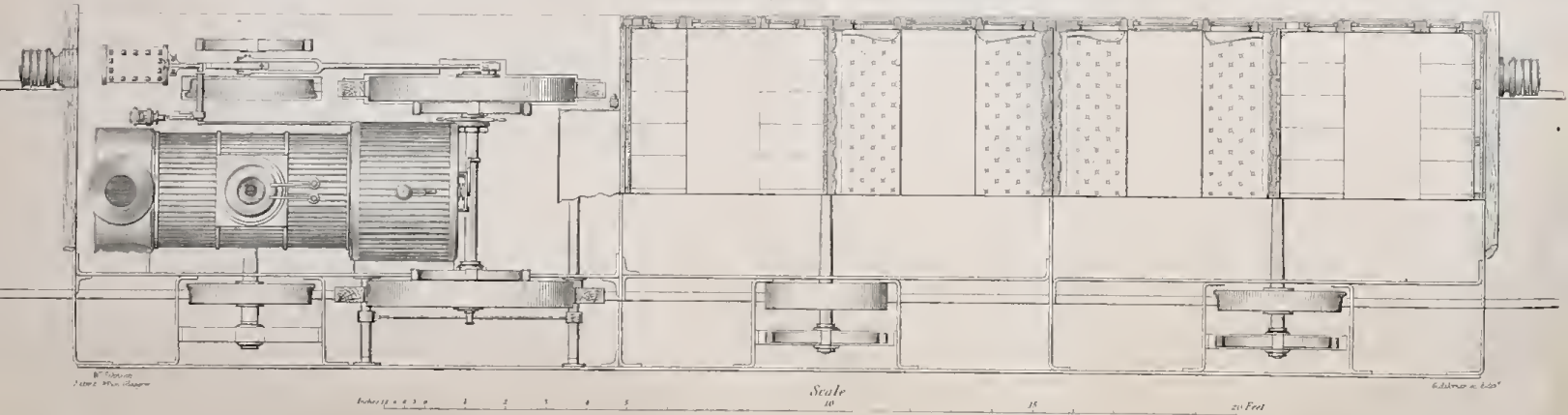
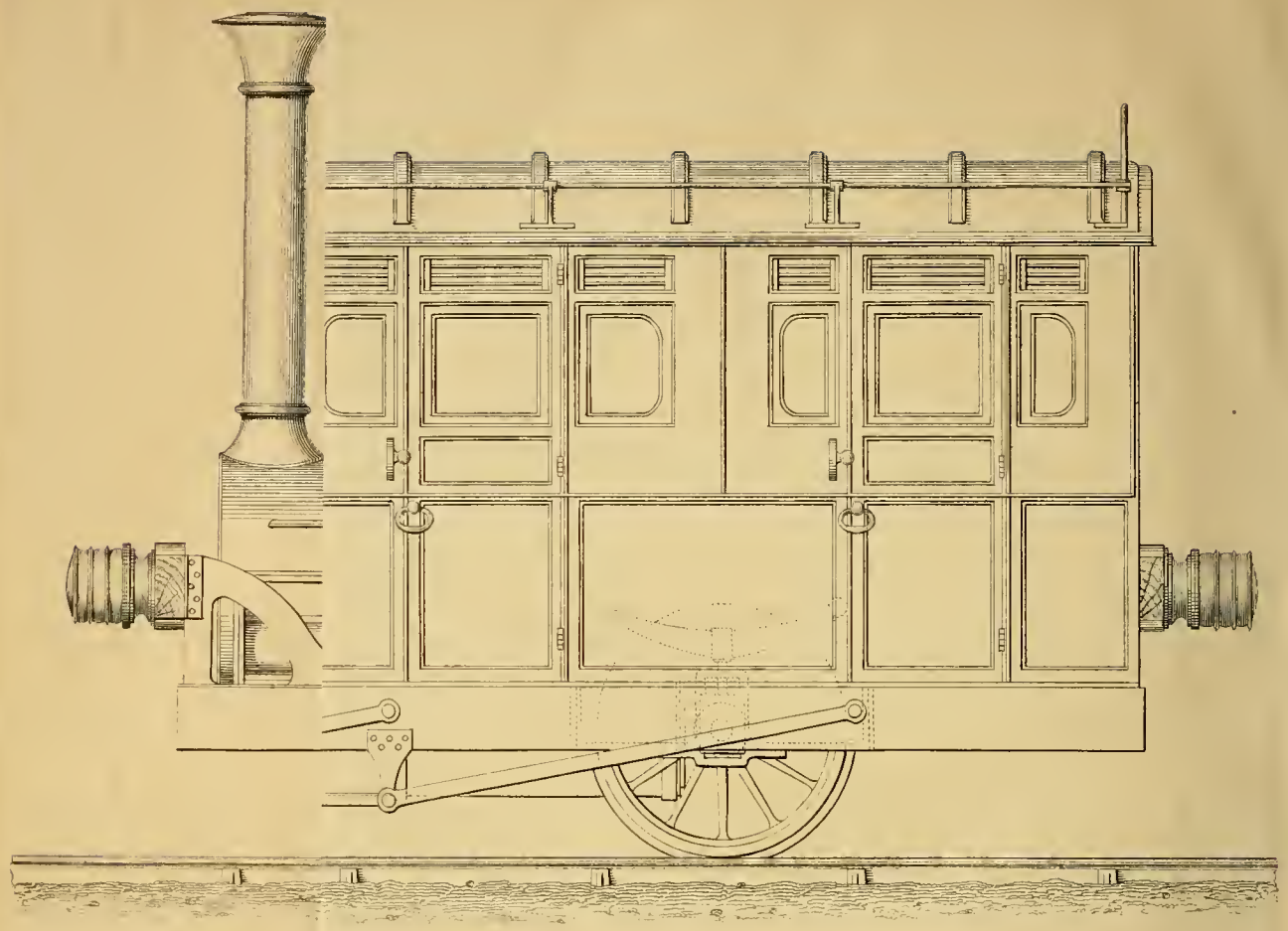
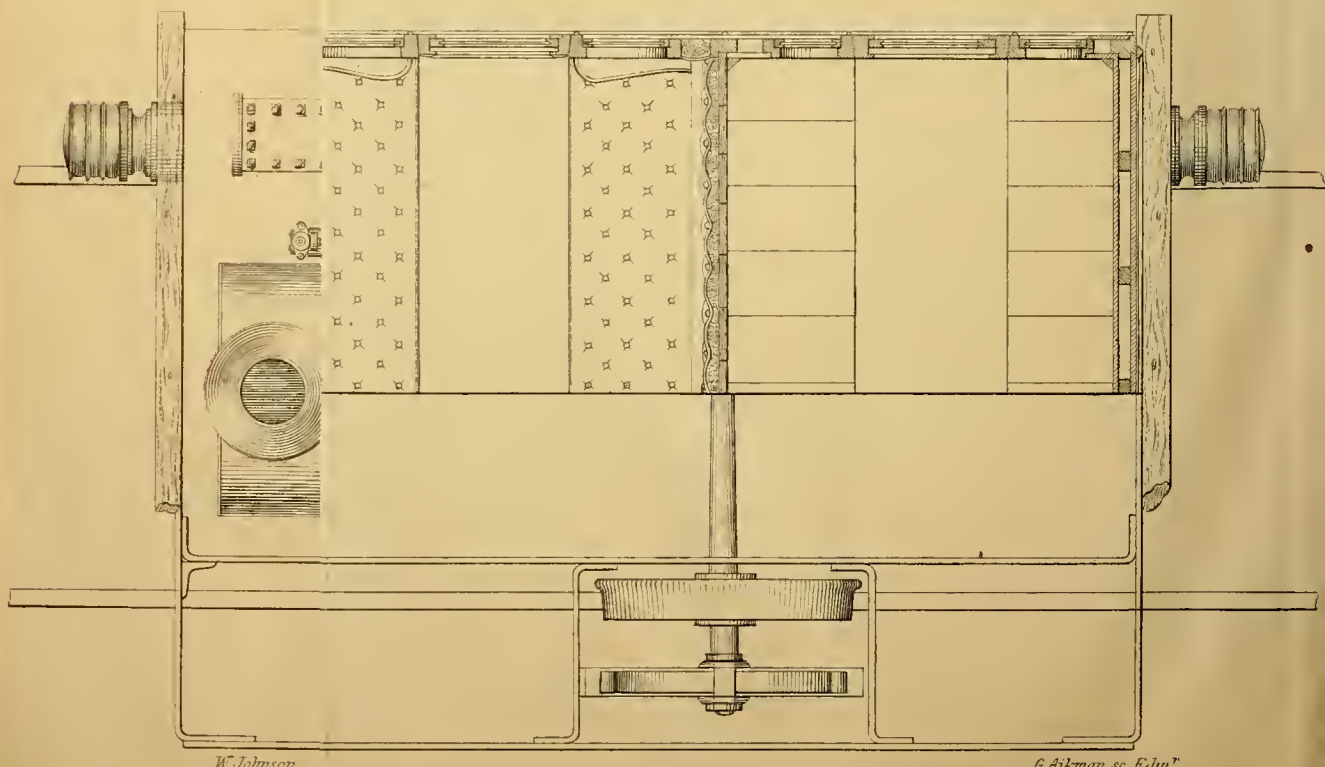


Fig 2







W. Johnson, Patent Office, Glasgo

G. Aikman, sc Edin^r.

20 Feet

RAILWAY ECONOMICS.

ADAMS' LOCOMOTIVE CARRIAGE FOR BRANCH TRAFFIC.

Illustrated by Plate 20.

The late revelations concerning the prospects of a number of the railways in this country, have had due effect in drawing attention to the general economics of the system; and the most active members of the directorship are now redoubling their endeavours in the reduction of the present overpowering amount of working expenses. Whoever can master that most incomprehensible document—a railway balance-sheet, will find that, in the excess of cases, the cost of locomotive power, with the collateral expenses, stand in a very unpromising relation to the quantity of duty really performed. In most of the branch lines, this discrepancy assumes a very formidable appearance, and we could name many instances where the branch passenger traffic is not only unremunerative, but is actually worked at a loss. Hence arises a very serious item on the wrong side of the railway ledger; and the slow progress of some of the most magnificent main lines is, in a great measure, to be attributed to the continued pecuniary drag of their inferior branches, which, so far from rendering effective service as feeders to the grand stream of traffic, are virtually remorseless suckers.

For years back the rate of travelling has gradually increased, and the public, now made aware of the powers of the system, is ever anxious for a higher velocity. Whilst this demand has been attended to, little or no attention has been paid to a suitable modification in the construction of the conveying machinery. With the exception of increased strength and weight, in order to withstand the shocks of transit, the engines and carriages remain the same; but from the causes we have mentioned, they now exert a more powerfully deteriorating effect on the permanent way. The additional weight consequent upon this improvement in speed, although everywhere felt as an important drawback, is most injurious on the short and less frequented branches, where a careful examination has shown, that for every ton of passengers, there are no less than 26 tons of dead weight conveyed. Comparing this with omnibus conveyance, we find that the light London omnibuses carry a paying weight of 22 cwt. whilst their total dead weight is no more than 18 cwt.

Mr. Samuel, the talented resident engineer of the Eastern Counties Railway, who has the merit of having introduced the "express carriage engine" for casual purposes, has led the way in the furtherance of a plan for the nearer assimilation of the two cases we have compared, by the substitution of light "carriage engines" for the usual locomotive, and separate tender and train of carriages. One of these engines is now in progress of construction, under his superintendence, by Mr. Adams of the Fairfield Works, Bow, the patentee of the improvement, and the complete drawings of which form, in Plate 20, our illustration of this article.

It will be seen that the general arrangement of the carriage is that of a small four-wheeled locomotive, combined with a four-wheeled carriage of considerable length, the main framing of the two being continuous throughout. Fig. 1 is a full side elevation of the carriage-engine, as fully equipped for service; fig. 2 is a corresponding view of two half plans of the engine, one showing a complete external view of the machinery, and a horizontal section of the carriage to exhibit the seats, the other detailing the framing of the whole. The whole framing, with the exception of the two buffer bars, is of wrought iron, and is 8 feet 6 inches in width, bound together by deep cross bars, as shown in the half plan. The engine is of the outside-cylinder class, but owing to the smallness of the parts, the cylinder, as well as the whole of the driving machinery, is kept within the side framing. The cylinders are no more than 7 inches in diameter, with a 12-inch stroke; they are simply bolted down to the surface of a stout wrought iron plate, in the middle of which the boiler is placed. The driving-wheels are 5 feet in diameter, and, as well as the front pair of wheels of the carriage, are without flanges, those of the leading engine-wheels, and the hind pair of the carriage, being sufficient to retain the engine on the rails, whilst greater freedom is thus obtained for passing curves. The boiler is constructed in the usual manner, and is 5 feet in length, by 2 feet 6 inches in diameter, and has 115 1½-inch tubes 5 feet 3 inches long, giving 210 feet of tube-heating surface. The dimensions of the fire-box are 2 feet 10½ inches, by 2 feet 6 inches, being an area of 25 square feet, making the total heating surface 235 square feet. The water is carried below the floor of the carriage in wrought-iron tubes, 12 inches diameter, and 12 feet long. The coke is carried in a chest, placed behind the foot-plate of the engine, and immediately in front of the carriage head. The side frames are ingeniously trussed by diagonal bars of iron, and are thus rendered of great strength, without adding much weight to the machine. The leading engine-wheels, together with the running-wheels of the carriage, are 3 feet in diameter. The carriage is divided into four compartments, the two middle ones being for first-class, and the two external ones for second-class passengers, or they may be made to embrace the three classes in any desired proportion. The guard's seat is on the top of the carriage head, and he has here the same conveniences to be found in the ordinary detached carriages. A vertical shaft, with a hand-wheel on its upper end, passes down the side of the head, and is connected beneath the framing with two transverse rocking shafts, carrying the break-blocks, placed one on each side of the driving-wheels, thus giving the guard a ready means of control over the speed of the engine.

To bring up the buffers to the line of those of ordinary carriages, separate timber beams are passed across each end of the carriage, the front one being supported by neat wrought-iron brackets rising from the framing. The total weight of the whole, including its supply of coke and water, is not intended to be more than 10 tons; and accommodation will be afforded for 42 passengers, to convey which, at 40 miles per hour, the calculated consumption of coke is 7 lbs. per mile. Although this has not yet been tested, it is not to be understood as a mere matter of theoretical calculation, for Mr. Samuel's experience with his express engine has put him in possession of data available also for this case.

The express engine has two cylinders, each 3½ inches in diameter, and 6 inches stroke, and carries 7 passengers at an average speed of 30 miles per hour, although it has repeatedly attained a speed of 44 miles. Under these circumstances, its consumption of coke is about 3 lbs. per mile, its entire weight in working order being 25½ cwt. The number of miles run by this engine during six months of the present year was 5526, the quantity of coke consumed being 7 tons, 9 cwt. or about 3 lbs. per mile. Taking this as a guide, we have reason to suppose that the consumption of the carriage-engine will, at least, not exceed the calculations of Mr. Samuel, and in this respect alone great economy may be expected to result.

The lowering of the centre of gravity, to which point so much attention has been paid by engine-builders, is here most satisfactorily carried out, and the lateral oscillation so much felt in the present carriages at high speeds, will certainly be very considerably diminished. This fact is by no means to be neglected in the consideration of the working economy of the engine, and the wear and tear of the rails, as well as in the comfort which travellers experience in a steadily going carriage.

If this system of light carriages becomes general, and we do not see any countervailing objections to prevent it, branch lines of all classes may be constructed in a very economical manner, as lighter rails and sleepers will be perfectly safe under such small loads. Many of the present branches, which are now little better than a dead weight upon their parent trunks, may also be placed, by such means, in a remunerative position, as the unproductive, "or anti-dividend weight" of the trains will be reduced to a minimum. The necessary weight of the carriage, with its load, or *paying weight*, are usefully employed in giving increased adhesion to the driving-wheels, which latter effect is a feature peculiar to the system, as the adhesive power in the large detached

engine is entirely dependent upon its unproductive weight. In combination with the carriage, the carried weight of the passengers acts as a most economical means of obtaining a good adhesive power, proportioned to the load, the one keeping pace with the other, whilst the detached engine acts only as a tug.

The plan offers to add considerably to what we may term the flexibility of the railway system. We shall be no longer compelled to employ heavy engines for an incommensurate traffic; and the consumption of 7 lbs. of coke per mile will stand very favourably, contrasted with that of 30 and 40 lbs. as at present.

A more frequent dispatch may also be taken as a valuable feature of the arrangement, as four light trains will be conveyed for the cost of a single one on the present system, the actual cost of conveyance of passengers being estimated at not more than one-fifth of a penny per mile.

The present amount of deterioration of rails alone is considered, by good authorities, to be not less than £80 per mile per annum; and any one who stands near the track of a heavy train at full speed, will see a sufficient amount of shaking and hammering to convince him that this sum is not over the mark. Another loss is sustained by the deflection of the rails beneath the excessive pressure of the 25-ton engines of the present day. The driving-wheels are practically ascending a constant incline, when the rails are actually laid on a dead level.

Whilst we write, information of the successful trial of a carriage-engine of a similar class, on the West London Railway, has reached us. Subsequently to the test of the express engine by Mr. Samuel, on the Eastern Counties Railway, Mr. C. H. Gregory, the engineer of the Bristol and Exeter (broad guage) line, was struck with the soundness of the proposed principle, and, acting upon his advice, the directors commissioned Messrs. Adams & Co. to construct a locomotive carriage to carry 50 passengers, first and second-class conjoined. This carriage, which is named the "Fairfield," ran its first trial trip on the 13th ult., and performed the feat of ascending a gradient of 1 in 100, 3½ miles in length, at a rate of 24 miles per hour, descending the same incline at the rate of 40 miles, and ran on the level at an average rate of 32 miles in the same time. She has two inside cylinders, 8 inches diameter, and 12 inches stroke, worked by a vertical tubular boiler, 6 feet high, and 3 feet diameter, fitted with 150 tubes. Fire-box, 2 feet 6 inches in diameter, and 2 feet high; driving-wheels, 4 feet 6 inches in diameter. The piston connecting-rods work a detached crank-shaft, communicating by means of side-rods with pins in the driving-wheels. The arrangement of the wheels differs from that of the engine we have engraved in several particulars. The engine has only its pair of drivers, the carriage portion having two pairs of 3 feet 6 wheels, running loose on their axles, which again revolve in their own bearings, the centre pair of the series of three having a lateral traverse of 6 inches, to enable the carriage to pass curves with facility.

The working steam pressure is 100 lbs. the consumption of coke being from 8 to 10 lbs. per mile. Total weight, with coke and water for a 40 mile trip, 9 tons. Length of whole machine, 39 feet. The separate crank-shaft will afford the means of applying differential band-pulleys to connect the pistons with the driving-wheels, should it be found advantageous to reduce the speed of the former, as this plan is quite feasible with *light* engines, although it would be totally inapplicable to heavy ones.

The working of the "Fairfield" has exemplified the greater safety involved in the principle, as compared with trains, for the speed is quickly got up, and may be as quickly reduced in case of meeting with any obstacle; and the centre of gravity is so much lowered, that the bottom of the machine is only 9 inches from the rails.

Mr. Adams proposes to place thin metallic pipes beneath the carriage seats, to be filled with hot water, as a simple warming apparatus for long journeys in cold weather. There is little doubt but that the time will arrive, when the journey from London to Edinburgh or Glasgow will be performed in carriages of this class, without any positive necessity for the travellers to alight; for, by a little further modification, refreshments might be provided, and, instead of a mere cramped ride, the extended conveniences at present to be found only in some of the American carriages, would furnish comforts now unheard of here. Thus a new feature may be opened up in railway travelling, and from being economizers only in branch traffic, the carriage-engines may ultimately be the means of introducing quick travelling universally, whilst on short branches the engine-man and stoker may represent the omnibus-driver and conductor, thus dispensing with station-clerks and their contingent expenses.

Amongst the many departments of railway operation, we know of none better calculated to diminish the working expenses, and thus restore the wavering confidence of shareholders, than this, or some similar project. The engine we have engraved will shortly be at work on the Enfield and Edmonton branch of the Eastern Counties Railway, and we shall then have a full opportunity of judging as to the actual practicability and advantages which it appears to present.

OUTLINE OF ASTRONOMY.

No. III.—The Planets.

Amidst that infinite number of glittering points which we see scattered over the vault of heaven, and which preserve amongst themselves the same relative distance, there are eleven stars which move round the sun in pursuance of intricate laws, the investigation whereof is one of the chief objects of astronomical science.

Two of these planets, Mercury and Venus, are termed *inferior*, because their orbits are placed between the earth and the common centre; the others are termed *superior*, because their motions are performed outside of the earth's orbit. The motions of all are made from west to east, in a zone of the celestial sphere called the zodiac, the breadth of which is divided into two equal parts by the ecliptic. Besides this motion, the planets and their satellites have a rotatory motion on their axes, similar to the one which affects our planet, and which has caused them to bulge at their equators, and to be flattened at their poles.

Those secondary bodies which turn round the principal planets, the moon for example, we term *satellites*. These have a triple motion—a motion upon their axes, a motion round the planet to which they are attached, and a motion round the sun, which they accomplish by following their own planet.

The periodical revolution of the planets, or the times which they occupy in returning to the same point of the heavens, are discovered by observing their return to the same star. Mercury and Venus, which always accompany the sun, are sometimes following, sometimes preceding him; and their return to the same situation, or to the same position, with reference to the sun, is 116 days for Mercury, and 584 days for Venus; but since the earth has, during that space of time, described an arc, which takes Mercury 28 days to make up, the actual time of his revolution is only 88 days. Both these planets perform their revolutions in less time than the earth; therefore, when they are beyond the sun they appear to travel, as in reality is the case, from west to east, that is, towards the left; but when they are between the earth and the sun, since they travel quicker than the earth, they appear to retrograde and to travel from east to west. A little consideration will prove that this must necessarily be the appearance of the phenomenon. Between the direct motion and the retrograde motion there is a transition state, that is, a time when the planet seems stationary. The visual rays are then parallel to each other, and the planet seems to keep its position relatively to the same stars.

Mercury is distant from the sun about 40,359,000 miles, and, as we have said, it performs its revolution in 88 days. It turns on its axis in 24 hours 5 minutes. Its diameter is 3350 miles, and the light of the sun upon it is seven times lighter, and the heat seven times more considerable, than the light and heat of our brightest and warmest summers. It is never farther from the sun than 32°. When it begins to appear of an evening, it is hardly distinguishable in the twilight; but it grows more and more disengaged, and after attaining a distance of 25° or thereabouts, it returns towards the sun. During this time the motion of Mercury is direct; but when, on its return, it has attained to a distance of 20° from the sun it appears stationary, and its following motion is retrograde. Continuing its approach to the central luminary, it is finally lost to our sight amongst its rays; and having remained a short time invisible to us, it again comes into sight in a morning, and separates itself from the sun. Sometimes, in the interval between its disappearance in an evening and its reappearance in a morning, the planet is seen projected on the sun's disc in the shape of a black spot, and this loss of its luminosity proves

that its lustre is borrowed. When Mercury is looked at through a strong telescope, it is seen to have phases like our own moon's, with a direction like the latter's towards the sun.

Venus has its orbit placed between those of Mercury and the Earth. With phases more plainly visible, and oscillations of greater extent and longer duration, this planet presents the same general appearance as Mercury. Its light is white, and it is easily distinguishable. It is never seen for more than three or four hours a day,—if it is evening, in the east; if it is morning, in the west. When visible before sunrise it formerly had bestowed upon it, the name of the Morning Star or Lucifer, and after sunset the Evening Star or Vesper, because it was taken for two different stars. Its light is most brilliant when at its quarters, and not when full, because at that time it is on the other side of the sun, and is most distant from the earth. Its mean distance from the sun is about 75 millions of miles. Supposing there to be no difference between the atmospherical phenomena of Venus and our own planet, the heat and light at the former will be twice as great as at the latter. Its revolution is performed in 224 days 16 hours, which makes 1° 36′ in a day, and a rapidity of 1464 miles per minute. The plane of its orbit is inclined 3° 24′ to the ecliptic, and the planet seems sometimes to diverge from that circle nearly 9°. An observation of the spots on Venus has shown that it turns on its axis in 23 hours 21 min. 19 sec.; and there are appearances which seem to warrant the conclusion, that there are inequalities on its surface four times more considerable than any on our globe. An atmosphere analogous to our own has been discovered; and a less flattening at the poles would seem to indicate a greater density than the earth, and a greater capacity of resisting the centrifugal force. In treating of attraction, we have seen the means of calculating the density of those planets which are accompanied by satellites; but Venus and Mercury being without attendants, it is only by analogy that we can estimate them.

The Earth.—After Mercury and Venus, the planet nearest the sun is that which we inhabit, the position and properties of which serve us for terms of comparison wherewith to estimate the positions and properties of the other celestial bodies. In reflecting upon the diurnal motion to which all those bodies are subject, we evidently recognize the existence of one and the same force which draws, or appears to draw, them all round the same point. The stars present the same appearances to us, whether we imagine the whole celestial vault to revolve round the earth, or the earth to revolve on its own axis in a contrary direction. It seems much more natural to take the latter as the true movement, and to regard the other as a mere appearance.

The earth is a globe with a radius of 4300 miles or thereabouts; the sun, as we have already stated, is very much larger, and distant about 23,000 terrestrial radii. Is it not more rational and more simple to suppose that our earth has a rotatory movement about its axis, than to imagine that a mass so considerable and distant as the sun should have a motion so extremely rapid (660 millions of miles in 24 hours), as to travel about the earth in a single day? And it is not only the sun but every star which presents the same difficulty, a difficulty which is at once removed by adopting the notion of a revolution of the earth round itself. Analogy also comes to our assistance in solving the difficulty. In all the other planets we find this rotatory movement directed from west to east, just like the apparent diurnal revolution of the stars seems to indicate in the earth. Jupiter, far larger than we are, moves on its axis in less than half a day, and a spectator on his surface would see the heavens turn round him in that space of time, and yet we know that such a revolution would be a mere illusory appearance. The supposition of an analogous motion in the earth is strikingly fortified by the fact, that the earth is flattened at her poles as Jupiter is; and we must conclude that the centrifugal force which causes the particles of a body to fly off from its axis of rotation has operated to flatten the earth at her poles, and to swell out the equator. This force would also diminish the weight at the terrestrial equator; and such a diminution is ascertained by experiments with the pendulum. Everything, then, conspires to the conclusion, that the earth does possess a rotation round itself, and that the diurnal revolution of the heavens is nothing but an illusion.

Now, since the diurnal revolution of the heavens is only an illusion produced by the rotation of the earth, it is natural to think that the annual revolution of the sun, carrying with him all the planets, is equally an illusion, owing to the motion of translation of the earth round the sun, and the following considerations leave no doubt on this head:—The masses of the sun and most of the planets are considerably greater than that of the earth. It is then much more simple to have the latter moving round the sun, than to set in motion round her, the whole solar system. What an extraordinary rapidity of motion must we attribute to Saturn, more than ten times farther from the sun, to the planets Uranus and Neptune, more distant still, in order to have them move every year round us, whilst they move also round the sun! This complication and rapidity of motion disappear by the motion of the translation of the earth, a motion conformable to the general law according to which the small celestial bodies circulate round great ones, to which they are neighbours. Let us convey ourselves in thought to the surface of the sun, and thence contemplate the earth and the planets, till these bodies would appear to us to move from west to east, and already that identity of direction is a promise of the earth's motion; but that which demonstrates it is the law, which exists between the times of the revolutions of the planets and their distances from the sun. They circulate round him more slowly as they are more distant, so that, as we have said before, the squares of the times of their revolutions are as the cubits of their mean distances from him. According to this remarkable law, the duration of the earth's revolution, supposing it to move round the sun, ought to be exactly that of the sidereal year. Is not this an incontestable proof that the earth moves like the other planets, and that it is subject to the same laws? In short, the idea of the earth's motion unites in its favour simplicity, analogy, and, generally, everything that characterizes the usual course of nature. We have seen, and in pursuing our investigations amongst celestial phenomena, we shall again and again be led to acknowledge this truth.

We may reckon five principal motions of the earth—1st, The motion round its axis of which we have just spoken, which, at the equator, is 1125 miles in the hour. We say at the equator, because of course in a sphere which turns upon its axis, the motion is less rapid the nearer we approach the poles. This motion causes the alternation of day and night, the inequality of which is owing to the inclination of the terrestrial axis on the plain of the ecliptic, or the route which the earth performs round the sun in one of its years. If the apparent motion of the sun were always made in the equator, the days and nights would be constantly equal, as at the lines of the equinoxes. 2nd, The movement in its orbit round the sun, which it performs in a year. The mean speed of the earth in its orbit is 1236 miles per minute. This prodigious motion, which is only half as quick as that of Mercury, brings about the periodical succession of the seasons, in consequence of the earth's axis being inclined $23\frac{1}{2}$° from the perpendicular in the plane of its orbit, and the tropics receiving by turns the perpendicular rays of the sun. 3rd, The motion of the points of the aphelion and the perihelion, round the ecliptic in about 21 millions of years, by which the length of the seasons is slowly altered. 4th, The progressive motion which causes a diminution in the obliquity of the ecliptic to the extent of 52 minutes in a century, and to a degree in 6700 years. This motion brings the tropics nearer one another, which were formerly, in all probability, further apart than at present. It has been conjectured, that this diminution may in the end cause the ecliptic to coincide with the equator, and so bring about a uniformity of season for some centuries on the whole earth; but exacter calculations would seem to show, that the augmentation or diminution of the obliquity of the ecliptic is only the effect of a libratory motion performed in an angle of three degrees. 5th, Of another motion of the earth, causing what is termed the procession of the equinoxes, we shall hereafter speak more in detail. It is a motion which has no other effect than to displace the constellations of the celestial signs which they occupied when the zodiac was first named, at which period the signs corresponded, as they no longer do, with the constellations.

Size of the Earth.—The observation of the altitude of the pole, or of the altitude of the sun, at the same period of the year, made in different countries in travelling from north to south, was the first thing which showed men that the earth was round. It was at first by the shadows of terrestrial objects that they found the difference of polar altitude. The farther they advanced to the north, the lower did the sun appear at midday, and the longer the shadows. This proved that the elevation of the sun above the horizon was less in the north than in the south, and that an observer in one was not in the same plane with an observer in the other. This point being established, the same phenomenon served to find out the extent of the rotundity by the measurement of a part. Thus it was observed, that a star which passed the zenith at midnight at Paris, was seen at that time to be a degree distant from the zenith when the observer was at Amiens, which lies directly to the north of Paris; and this proved that the earth between the two places has one degree of curvature. Now, an exact measurement of the distance gave $69\frac{1}{2}$ of our miles, and multiplying this by 360, we obtain 25,020 miles as the length of the earth's circumference.

However, it is to be remarked, that the length of a terrestrial degree is not in every place the same, in consequence of that flattening of the poles, and that bulging of the equator, to which we have frequently alluded. By ascertaining the length of a degree in different places with the utmost amount of accuracy, it has been found that the diameter of the earth, from pole to pole, is about $\frac{1}{3\,0\,0}$th less than the diameter at the equator. The bulging at the equator is further proved by the necessity which exists of shortening at the equator the pendulum of a clock, in

order to obtain the same number of vibrations in a given time that we have in northern regions; the reason being, that the surface of the earth is more distant from the centre of gravity at the equator than at the poles, and therefore that weights fall with less speed there.

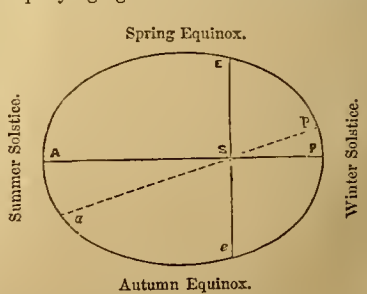
Latitude.—That which we mean by latitude is the distance of any given place from the terrestrial equator, or the distance of its zenith from the celestial equator. Under the equator where the latitude is = 0, the celestial poles are at the horizon. Advancing a degree towards the north, the pole-star would seem to be elevated a degree, and so in leaving the equator the pole will be elevated as many degrees as we have left the equator behind. The altitude of the pole is then equal to the latitude, or to the distance from the equator. Latitude being also the distance of the zenith from the celestial equator, we can find it without having recourse to the stars, by measuring the height of the sun at noon, no matter what the time of year may be, and this is the theory of the method. The celestial equator is directly over the terrestrial equator, so that at whatever distance a given place on the earth may be from the terrestrial equator, the point in the heavens directly above it, which we term the zenith, is distant exactly the same number of degrees from the celestial equator. The sun reaches the equinox twice in the year, viz.: on the 20th March, and the 23d September. At these periods it is on the equator; between March and September, it is to the north of the equator; and between September and March, to the south. The number of degrees by which the sun is distant from the equinox on any day, is termed the declination of the sun; and tables have been calculated, showing the declination of the sun at noon; in other words, its distance from the equator, for every day of the year. By observing at noon the height of the sun above the horizon, at the place where we happen to be, we can easily find the altitude of the equator, and then the distance of the zenith from the equator, or the latitude of the place. For example, to find the latitude of a vessel crossing the Northern Atlantic, on the 13th October, 1848,—a mariner ascertains the altitude of the sun at noon, which he does by means of an instrument called a quadrant. The Nautical Almanac then supplies him with the calculated declination of the sun. The observed altitude being 44° 23′, he subtracts the declination 7° 56′, and there will remain 36° 27′, which is exactly the altitude of the equator above the horizon, at the spot where the observation is made. He then subtracts that altitude from 90°, because the latitude is that which would be wanting at the equator to make up 90°. There will remain 37° 41′ as the latitude of the ship at noon on that day. If the vessel had been to the south of the equator, it would have been necessary to add the declination to the observed altitude, which operation would have given the highest point of the equator above the horizon, and that number being subtracted from 90°, the remainder would give the latitude of the place.

Longitude.—In addition to measuring the distance from the equator to the poles, it is necessary to measure distances in the other direction, from west to east, and this is termed the longitude. In order to do this, we must imagine several curved lines, perpendicular to the equator, passing through the two poles. These are the terrestrial meridians, so termed because, when the earth moving on its axis presents one of these lines to the sun, that luminary is then at its greatest altitude for all the places which are situate along that line. Usually we draw 24 of these lines, at equal distances, upon our globes, representing the 24 hours of the day; but we must always suppose that there are as many lines as there are points on the surface of the earth. The degrees of longitude become shorter as we approach the poles, as we may see by reference to a globe, where all the lines approach one another as they leave the equator, until they meet in a point at the poles. The first meridian line is taken arbitrarily, because, strictly speaking, there is neither east nor west, and at every instant of time there is some place where the sun is rising, and another where he is setting. It is therefore usual for astronomers and geographers to reckon the longitude from some place in their own country. In Great Britain, we calculate from the Observatory at Greenwich; and we say, if a place is west of Greenwich, that its longitude is west; if east, then that its longitude is east. The circumference of the earth being 360°, since it turns on its axis from west to east in 24 hours, it passes through 15° each hour, and therefore all places, the meridian of which is distant 15° to the east of Greenwich, will have noon one hour earlier than at Greenwich, for a reason which will at once occur to the reader. It follows, that in travelling towards the east, we shall have noon an hour earlier every day, for each 15° we pass over, that is, four minutes for each degree. Let us suppose that two travellers leave London the same day, and the same hour, one bending his course towards the west, the other towards the east. Now the latter, gaining one hour for each 15°, will, by the time he has voyaged round the world, and reached London again, after travelling over 24 times 15°, be a day beforehand in his reckoning. With him it will be Sunday, when at London it is Saturday; and, as to the other traveller, he will have lost a day, and with him it will be Friday. The longitude may be discovered by means of eclipses. Suppose that an eclipse was observed at Glasgow at midnight, and in India at six o'clock in the morning, we are certain that the difference between these two meridians is six hours, or 90°. But as eclipses are not common, and navigators are perpetually requiring to know the longitude of the place where they happen to be, they use another method for obtaining the longitude. By observing the place of the moon, with reference to the stars, at a given hour, and by consulting tables calculated beforehand, they readily ascertain the precise longitude. This method of calculating by the moon may even be dispensed with, if we carry a chronometer which keeps accurate time. On leaving port, a navigator regulates the chronometer by the meridian of the place, and if, after voyaging for some days, he finds that the watch is 64 minutes in advance of the sun at noon, he knows that the place he has arrived at is 16° of longitude distant from the port, because the sun passes through a degree in four minutes.

Antipodes.—Every two points of the globe's surface, which are diametrically opposite to one another, are called antipodes. These points have the same plane for their horizon, but the upper face of that plane is seen from one, and the lower face from the other. A star rising above one horizon sets in the other; the longest day at one is the shortest at the other; the seasons, and day and night, are exactly reversed. If the diurnal motion has been rightly comprehended, these differences in the two places will be also understood, because it will be seen that we are, at any given moment, in the position where persons on the other side of the world will be in twelve hours afterwards. And as to the objection that we must have our head sometimes upwards, sometimes downwards, it vanishes when we consider that the laws of gravitation prove that, in the infinity of space, there is neither high nor low.

The Seasons and the Apsidal Motion.—The rays of the sun have most power when they strike perpendicularly downwards. The nearer we approach the poles, the more oblique is the direction of the rays; and when we are at 45° of latitude, and the sun is in the equator, it only rises to an altitude of 45° at noon, because its altitude at the equinoxes is always the complement of the latitude, and makes up 90° with it. The direct distance of the sun has very little influence upon the temperature —it is indeed a million and a half of miles nearer our hemisphere in winter than in summer, and the intensity of the heat proceeds from the greater length of time it remains above the horizon, and the direction of its rays. The sun is also a longer time in the northern than in the southern hemisphere, on account of the eccentricity of the earth's orbit; the difference is 7¾ days, and this produces a remarkable inequality in the seasons; an inequality which varies in the course of centuries, and is repeated after a revolution of 21,000 years. This is one of the most interesting facts in astronomy, and merits a particular explanation.

We know that the planets move in ellipses, the sun being in one of the foci. That place in the ecliptic where the earth is nearest the sun we name the perihelion, and that where it is farthest away the aphelion. The line joining these two points is the greater axis of the ellipse, and is termed the line of the apsides. The points of the earth's perihelion and aphelion are not stationary: they advance in the order of the signs 1′ 2″ in a year, 30° in 1744 years, and the whole circuit of the ecliptic is made in 20,931 years. This motion has been attributed to the action of Venus and Jupiter. The movement of the terrestrial ellipse being acknowledged, it will be seen that, at a certain epoch, the greater axis will coincide with the line of the equinox, and at another be perpendicular to it. These epochs are easy to calculate, since we know the actual position of the axis and its motion. About the 1250th year of our era the perihelion coincided with the winter solstice, and the aphelion with the summer solstice, as is shown in the accompanying figure. A Points out the earth's aphelion, P the perihelion, S the sun's place. It takes 5233 years for the greater axis to change from this position, and to coincide with the line, E *e*; and this event would take place about the year 6483 of our era, and the perihelion will then coincide with the autumn equinox. When the greater axis, A P, is perpendicular to the line of the equinoxes, the equator, E *e*, divides the ellipse into two unequal parts, the lesser of which is situate on the perihelion side. Now, as the surfaces described are proportional to the times, the arc, E P *e*, will be sooner passed over than the remaining parts of the ellipse. And thus



the length of the seasons is rendered unequal with reference to each other, and continually varying. In 1250, the perihelion coincided with the winter solstice, and the time elapsed between the spring equinox, E, and the summer solstice, A, was equal to the interval between that solstice and the autumn equinox, and the spring was then equal to the summer, and the autumn to winter. At this time the line of the apsides cuts that of the equinoxes, as shown by the dotted line, *a p*. The perihelion, P, has moved 10° from the winter solstice, and the arcs which the ecliptic describes, and which answer to the different seasons, are unequal to this extent:—

Spring,.....92·90 days.
Summer,.....93·56 "
Autumn,.....89·69 "
Winter,.....89.07 "

As long as the perihelion remains on the side of the equator where it is now, the spring and the summer, taken together, will be longer than the autumn and winter. About the year 6463, these intervals will become equal when the perihelion reaches the spring equinox. It will then pass by it, and the spring and summer, taken together, will be shorter than the autumn and winter. This motion of the apsides not only operates to vary the length of the seasons, but to change the physical aspect of the globe.

The earth in its perihelion being so much more distant from the sun than in its aphelion, the attraction or centripetal force is increased more than a fifth; and to neutralize it, the orbicular motion causes the earth to describe 61′ per diem, instead of 57′, its motion at its aphelion, or 59′, which is its mean motion.

THE RESISTANCE TO RAILWAY TRAINS.

A CONTRIBUTION PROFFERED FOR THE BEHOOF OF RAILWAY SHAREHOLDERS.

Hackneyed and time-worn as is this subject, it is not yet, be it said to our country's disgrace, worn threadbare. The whole host of the British Association, and a Mr. W. Harding, if I read rightly, have long been employed upon it; Mr. Barlow has also put a finger in the pie, and Mr. Scott Russell, having amalgamated his own with their experimental facts, has produced a law, a table, and a formula—which two former are about to be examined.

Man is born with the faculty of communicating his simple ideas, or sensations, by sounds; but to exchange complex notions, demands an intelligence only to be acquired by stirring up the reasoning faculty, and thenceforward patiently submitting to long and laboured study. The child has an instinctive thirst for knowledge when delivered orally, but naturalists have not yet made out, that as years advance upon years, the man desires more of truth than is commonly wrapt in outside show, excepting when spurred on by self-aggrandizement, pecuniary or honorary.

Profiting, then, by this seeming lapse in the predilections of men,—so many are deeply self-interested in the vitality of this subject, either as shareholders, directors, engineers, brokers, or as mathematicians in connection with railways, and so many hundreds of millions of hard-earned cash have been disbursed upon them,—no other apology seems due for the presumption of this attempt, to lay prostrate the work done by the able men above named, than to declare at once, that their rules and experiments are vastly at variance; that, consequently, one or other is bad; and so, unless their rules be mended, the shares, already low enough at market price, will ere long be quoted minus nothing.

Resistance has been employed as a term conveying a simple idea, whereas no word comprises a greater complexity of cases, and of cases subject to a greater diversity of ratio, according as the resistance be taken relatively to time, space, or otherwise. This defect in our language will be cleared up, by afterwards defining express terms for express cases. The matter to be examined is published in "Adcock's Engineer's Pocket Book" for last year, and the article is transcribed verbatim below.

RESISTANCE TO RAILWAY TRAINS.

The resistance of the air to railway trains is estimated by Mr. Barlow at not more than 10 lbs. on each ton weight, on the average. The loss of velocity estimated by comparison of the actual with the theoretical velocity, is caused by the consumption of power in overcoming the inertia of the train, and not from defect or loss of power in the action of the engine.

A paper was read at the meeting of the British Association in September, by Mr. Scott Russell, on "The law which governs the resistance to the motion of railway trains at high velocities." His experiments have been undertaken "on a large scale, with railway trains of a great variety of size and weight, and at velocities as high as 61 miles an hour," and were combined with those formerly made by the Association, and by Mr. W. Harding, and he presents the results in the following table.

Mr. Russell remarks, that the experiments show not only a great amount of resistance at high velocities, but likewise a great variation and anomaly in the results. He describes the resistance as consisting of three elements. Firstly, The friction on the wheels and axles, as an ascertained quantity, equal in the best carriages to three lbs. per ton of the train; secondly, the resistance of the air, which acting on a solid body, such as a railway train, he regards as much less in amount than that inferred by Smeaton, from experiments on thin plates; and thirdly, a large amount of resistance, increasing with the velocity of the train, and amounting, at 10 miles an hour, to about 3 lbs. per ton; at 30 miles, to 10 lbs.; and at 60 miles an hour to 20 lbs. per ton; and which Mr. Russell ascribes to the concussions, oscillations, frictions of various kinds, &c., which are produced at high velocities.

Mr. Russell has constructed a formula, compounded of these resistances, the comparison of the results of which, with those of the actual experiments, is shown in the table; but the great anomalies observable at the various velocities remain yet unexplained, and appear incapable of being accounted for on any theory. Much is probably due to the combined action of inaccuracy of construction, and variation in the quality of the materials employed. A doubt may likewise be suggested, whether, in practice with heavy trains, the friction of the axles, &c., is constant at all velocities.

TABLE REFERRED TO ABOVE.

No. of Experiment.	Uniform velocity maintained in miles per hour.	Resistance in lbs. per ton by experiment.	Resistance in lbs. per ton by formula.
1	10	8·40	9·30
2	14	12·60	13·90
3	14	12·60	13·90
4	29	16·50	15·70
5	31	23·30	25·40
6	31	18·20	16·30
7	32	22·50	27·20
8	33	22·50	22·70
9	33	15·68	16·90
10	33	15·96	17·00
11	33	16·60	17·30
12	34	16·95	17·30
13	34	17·70	17·30
14	34	23·30	27·20
15	34	25·00	23·10
16	35	22·50	26·10
17	36	22·50	22·40
18	36	22·40	21·50
19	37	17·50	18·20
20	37	25·00	28·40
21	39	30·00	31·00
22	41	22·99	19·60
23	41	26·78	19·60
24	45	21·70	21·00
25	46	23·10	21·30
26	46	30·31	31·00
27	47	33·70	33·10
28	50	32·90	36·30
29	51	26·40	23·00
30	53	41·70	42·10
31	61	52·60	54·80

It thereby first appears, that Mr. Barlow has estimated the resistance of the air to railway trains, at not more than 10 lbs. on each ton weight, *on the average*. Verily this is saying but little to the purpose, and in fact it amounts to just nothing, since we do not find that he has given an estimate of the weight of each train, and from the average of the aggregate of all which, he has estimated the actual resistance. Had any common man said the same, he would have been laughed at, more especially as he has not shown the average velocity; but his high station at Woolwich entitles him to a reply—and I say, that whether a train be empty or full, light or heavy, the resistance of the air thereto will be the same; consequently, as Mr. Barlow has not described an average weight and velocity, his rule is inapplicable to the case, and totally unserviceable to the mechanic.

Mr. Barlow further enlightens us by saying, "The loss of velocity is caused by the consumption of power in overcoming the inertia of the train." Veritably it is so for one minute, and perhaps for two minutes, after the train has started; but whenever it has acquired a uniform speed, the inertia ceases, and momentum takes its place; so that the tendency to continue in motion without any extrinsic aid, is just equal to the power expended in overcoming the inertia of the train, whilst its motion was variable and increasing;—whence all that can be made out of Mr. Barlow's evidence on this head is, that if, by some enchanted mathematical wand, matter were dispossessed of its inertia, a train would dart off at its full speed—and so would a race-horse!

We will now quit Mr. Barlow, and turn to the rules of Mr. Scott Russell, by whom we are formally instructed that the resistance consists of three elements. Firstly: The friction on the axles and wheels, as an *ascertained* quantity, amounting to 6 lbs. per ton of the train in the best carriages. Secondly: The resistance of the air—but the amount he leaves indefinite. Thirdly: A large amount of resistance, arising from concussions, oscillations, frictions of various kinds, *et cetera*, increasing with the velocity of the train, and amounting, at 10 miles an hour, to about 3 lbs. per ton; at 30 miles, to 10 lbs.; and at 60 miles an hour, to 20 lbs. per ton.

It is now our business to compare these elementary laws of resistances with the table of resistances at various speeds, compiled by Mr. Russell "from experiments undertaken on a large scale, with railway trains of a great variety of size and weight, and at velocities as high as 61 miles an hour." By some *mishap* the table does not furnish the resistance at 30 or 60 miles an hour; but, as the resistance at 61 miles is 52·60 lbs., it may (not to split straws with Mr. Russell) be taken at 52 lbs. when the speed is 60 miles an hour.

The resistance at 30 miles must be taken at compromise—at 31 miles an hour it is 23·30 lbs., while at 33 miles it is as low as 15·68 lbs. This

experimental vagary not having been accounted for, we will bluster through it, and set the resistance down at 16 lbs. when the speed is 30 miles an hour. Then a comparison of the rules and experiments will be as follows:—

At 10 miles an hour.—Friction 6 + concussions, &c. 3 = 9 lbs. The resistance by experiment, and which necessarily includes that of the air, is 8·4 lbs. The atmospheric resistance is therefore 6 lb. less than nothing.

At 30 miles an hour.—Friction 6 + concussions, &c. 10 = 16 lbs., or just equal to the resistance by experiment as taken above; consequently, at 30 miles an hour, the resistance of the atmosphere is = 0.

At 60 miles an hour.—Friction 6 + concussions, &c. 20 = 26 lbs. The resistance, as taken from experiment, being 52 lbs., it follows that, at 60 miles an hour, the resistance of the air to the train is 26 lbs. for each ton of its weight.

Railway directors don't know what this means, or they would not sit so softly on their cushions; therefore it shall be put into downright plain English. We will suppose a train of 100 tons moving at 60 miles an hour, or 5280 feet per minute, and meeting a constant resistance of 26 lbs. for each ton of its weight. Then the whole resistance per minute, represented in lbs. × feet, is 26 × 100 × 5280 = 13,728,000; which amount being divided by 33,000 is 416, the number of horses' power of the locomotive consumed in overcoming the resistance of the atmosphere only, according to Mr. Russell's rules and table.

On this appalling recital I beg to hold a parley with the plain common sense of the shareholders, a commodity scarce enough now-a-days, but a grain of which is of more value than a ton in weight of the servile nonsense we have seen. Four hundred and sixteen horses are required to break through the atmosphere when a train goes 60 miles an hour, but at 30 miles the power is reduced to nothing. When the soul of reason has run out at the elbows this will be believed; but I ask the shareholders if it be true, and every man answers—No. I ask their reason, and the reply is, that as the wind has power to grind corn, and move stately and prodigious weighty ships through the water, when its speed is vastly under 30 miles an hour, the rule of Mr. Russell must be in error, or else his experiments. Moreover, they say, when the air moves at 19·5 miles an hour, it is described by Mr. Rous and his co-experimentalist as "a very brisk gale;" so that at 30 miles its effect will be $\left(\frac{30^2}{19{\cdot}5^2}\right)$ equal to two and full one-third very brisk gales, or as 2·36 to 1.

Mr. Russell has made mention of "great anomalies" observable at various velocities, which seem to him *incapable of being accounted for on any theory.* These anomalies, the plain reading of which should be, the *ups* and *downs* of the table, are to be accounted for thus:—Supposing the experiments to have been all made on a level railway, and taking as granted that the diameter of the carriage wheels, in all the experiments, bore one and the same proportion to that of their axes—reservations to which I am entitled; for if they were not so, the experimentalist would have been as judiciously employed at the game of marbles, which is in part, of skill, and in other part, of chance;—I say, the anomalies of the table are to be ascribed to one of the three following causes, or to the three conjointly:—First: The weights of the train in the different experiments, were differently proportioned to the surface of train resisted by the air; or, Second, The air was not calm at the time of all the experiments; and, Third, The friction on the axle has been taken according to the gross weight of the train, instead of being taken proportional to the weight resting on the axis.

I now say, and without diffidence, in the face of about 3000 railway directors, whose names appear in Tuck's Railway Directory, that, instead of moving for the interest of their employers, they have submitted to be the dupes of a band of experimenters, urged on by no rule of action, save that of caprice, whereby their labour, according to Mr. Russell's confession, is labour in vain; and the talent engaged is developed to no purpose beyond that of rendering a plain subject intricate and obscure. You, shareholders, being yet in the full vigour of common reason, and which is of more worth than all the vague apophthegms of the civil engineers on whose works and doings we are commenting, will listen whilst I say, that trusting to the million is trusting to no responsible agent; but if you be in search of truth, the anomalies are still to be unravelled, by a code of simple experiments, framed and devised, not by a multitude of heads, which are so apt to split and confuse each other, but by one head only.

Next, gentlemen shareholders, let us calmly inquire, whether or not the friction on the axes of the carriages be an ascertained quantity, taken relatively to the gross weight of the train. Mr. Russell first asserted it, and thereon established his first element of resistance; but, afterwards, we find "a doubt may be suggested, whether, in practice with heavy trains, the quantity of the first-named element of resistance, the friction of the axles, &c. is constant at all velocities." Such interminable nonsense must be abated, before your money is laid out to the best advantage. A rule is set up one moment as absolute, to be knocked down the next; and I will presently do my best to serve the third element the same.

The friction on the axis, let me say, is not yet an ascertained quantity, nor can it be ascertained in reference to the gross weight of a train; but it may be ascertained referentially to the weight of a train, less that of its wheels and axles, when their respective diameters are given. Thus, if the wheels and axles of a carriage weigh a ton, and its total weight be three tons, the friction on the axle will be proportional to the weight of two tons, and if loaded, it will be proportional to the superincumbent weight on the axis whatever it be; but, as the wheels and axles will continue of the same weight whether the carriage be loaded or empty, the friction will bear no definite proportion to the total weight—consequently, that rule is bad which prescribes a resistance, arising from the element of friction on the axis, as an ascertained quantity in relation to the total weight of the carriage and its load: and so the projector of the rule has stultified himself, and shown up his incapacity to analyze plain matter-of-fact subjects. As to the force of the wind, it has been accurately determined by Mr. Rous, Dr. Lind, and Colonel Beaufoy, when acting on a plain surface at rest. I have said accurately, for it differs from the true theory only 3·9 per cent. We will now turn the tables, and suppose the air at rest, and a body progressing through it at any given speed (being the case applicable to the railway train), and I desire to learn if the resistance will be the same as in the former case? You shareholders answer—No. I ask why? and you reply,—the noted mathematician Dr. Hutton asserted their equality, but never attempted to prove it. Nevertheless, simpletons have believed him; but wiser men hold by the doctrine of W. Emerson, who proved to a demonstration that the two cases differ in the proportion of 1 to 2—so that the pressure of the wind, at any given velocity on a body at rest, is exactly equal to twice the resistance the same body would sustain, supposing the air at rest, and the body in motion through it, at a speed equal to that of the wind in the previous cases.

Mr. Russell's third element of resistance is of such dubious import, that, when the rails are clean and passably well laid, I should dismiss it altogether, provided the cylinders of the locomotive, instead of being parallel to each other, were in the same line. We, however, are not put in possession of the manner in which the resistance on the axis was ascertained, nor can we judge of the equitable adjustment of that portion of resistance assigned to concussions, &c. But Mr. Russell's notions are so diverse from those of others on the point, that the true quantum must still be considered a profound secret. For example, Mr. Templeton has made experiments on these matters, and, according thereto, the resistance presented by adhesion, inequalities, &c. on the peripheries of the wheels at 60 miles an hour, is to the friction on the axis as 3 to 3, whereas by Mr. Russell it is as 3 to 1.

Instead of keeping in the wake of either one or other, I say it is no matter of doubt, as has been suggested, that, as the velocity increases, the rate of friction on the axis will be subdued, for three reasons. First: On a slender unstable railway, such as are in use, the rails will bend, so that the full weight of the train at high speeds has not time to press upon it. For this reason, an undulating railway might be passed over by less power than one substantial and firm. Second: Independently of such consideration, the friction on the axis would be reduced at high speeds, in consequence of *the gravity of the train being less when in motion than when at rest;* and the greater the speed, to a certain extent, the more it is reduced. Third: The greater the speed of the train, the higher will be the temperature of the matter employed to lubricate the axis—consequently, the less will be its tenacity. And as the axles are not in contact with the boxes in which they move, but with the matter mentioned, the friction will on such account be reduced. Then, to steer a middle course between Mr. Templeton and Mr. Russell, I shall make a set-off of the reduced friction on the axle at increased velocities, against the increased resistances from concussions on the periphery of the wheel, &c.; a compromise not to be objected to, as so little of the fact has yet been determined and agreed on between mathematicians, engineers, and experimentalists. The friction on the axis, as I find by experiment, when the speed is a minimum, and the diameter of the wheels to that of the axis as 12 to 1, is as 1 to 124. In other words, the fraction $\frac{1}{124}$ signifies, that 1 lb. falling perpendicularly, will move 124 lbs. horizontally, and as far and as fast as the 1 lb. falls, and which fraction will be termed the prime module of friction, when the wheels and axles are in the aforesaid proportion.

As to the resistance of the air to a train, Mr. Rous and others have found the pressure from the force of the wind on 1 square foot, when its velocity is 3000 feet per minute, to be 5·718 lbs. The resistance, therefore, from the cause already explained, on a square foot of the train as to be estimated, will be half the quantity, or 2·859 lbs.

Having, as I hope, rendered ample justice to the body of civil engineers and others named, by proving they have been contented with outside show, when they should have dipped deep into the marrow of the subject; and having also proposed certain principles, I am now about to apply them to a trial experiment, made between Derby and Masborough, according to the formulæ in a treatise entitled, "Railway Locomotion and Steam Navigation, their Principles and Practice." The particulars of the experiment are given in the "Practical Mechanic's Journal," page 59, and are comprised in what follows.

A locomotive, constructed by Sharp, Brothers, & Co. of Manchester, No. 60, with cylinders 16 inches diameter, and stroke 20 inches, the driving wheels 5 feet 6 inches diameter, ascended a gradient of the average rise of 1 in 330, at the rate of 3770 feet per minute, and went down a similar gradient at the rate of 5104 feet per minute—the gradients being of equal length, and the whole distance 40¾ miles. The weight of the engine, tender, nine first and second-class carriages, and two break-vans, together with the cargo, was 98 tons, or 219,520 lbs.

The surface of train opposed to the air, in the absence of better data, is roughly taken as follows:—

	Superficial Feet.
Cross section of one carriage,.....	50
The train would have about 48 pair of wheels and axles, the section of which would be about 240 feet. But wheels and axles being cylinders, the resistance to which is just half that on an equal plane surface, the surface is taken at	120
Sundry projections taken at	10
The train reduced to a plane surface equal to.....	180

The diameter of the wheels and axles of the carriages, &c., not being stated, will be taken as 48 inches to 3¼, in which case the prime module of friction is $\frac{1}{152}$. Then let the

Weight of engine and train in lbs. be.....	219520 = W.
From which, deducting one-third for weight of wheels and axles, and there remains whereon to estimate the friction,.....	146347 = W′
Speed up the gradient in feet per minute,.....	3770 = V.
Do. down do. do.	5104 = V′.
Gradient, one in	330 = G.
Prime module of friction,.....	152 = f.
Module of friction, or friction proportional to weight on axles,.....	= F.
Tendency of engine and train to descend a gradient when at rest thereon,.....	= w

By Theorem 6. $\frac{W}{G} = \frac{219520}{330} = 665$ lbs. = w, the tendency to descend the gradient.

Theorem 3. $\frac{W'}{f} = \frac{146347}{152} = 963$ lbs. = F, the modulus of friction.

Theorem 7. $\frac{V \times \overline{F + w}}{33000} = \frac{3770 \times \overline{963 + 665}}{33000} = 186$ — the horses' power in ascending the gradient, exclusive of the power required to overcome the resistance of the atmosphere.

And $\frac{\overset{\text{feet.}}{180} \times \overset{\text{lbs.}}{2{\cdot}859} \times \overset{\text{velocity.}}{3770}}{33000} \times \left(\frac{3770}{3000}\right)^2 = 92$ — the horses' power to overcome the atmospheric resistance.

Total power in ascending the gradient, 278 horses.

By the table of power at page 77 of the above-named treatise, the same quantity is required to overcome the resistance of the air. At 30 miles, the resistance is 3·54055 on 20 superficial feet, and 3770 feet per minute, is 42·84 miles an hour.

Then $3{\cdot}54055 \times \frac{180}{20} \times \left(\frac{42{\cdot}84}{30}\right)^3 = 92$ horses.

By changing the sign of w in theorem 7, the power down the gradient will be

$\frac{V' \times \overline{F - w}}{33000} = \frac{5104 \times \overline{963 - 665}}{33000} = 46$ horses, exclusive of the atmosphere,

and $\frac{180 \times 2{\cdot}859 \times 5104}{33000} = 230$ horses, the atmospheric resistance.

Total power down the gradient, 276 horses.

The mean power up and down the gradient is 277 horses, and which on a level railway would give a speed of 4408 feet per minute (= v), and the power would be disposed of as follows:

Theorem 8. $\frac{F \times v}{33000} = \frac{963 \times 4408}{33000} = 128{\cdot}6$ horses for the friction.

$\frac{2{\cdot}859 \times 180}{33000} \times \left(\frac{4408}{3000}\right)^2 = 148{\cdot}4$ do. for the resistance of the air.

Total power on a level railway, 277 horses.

Had the parties present at the trial experiment stated the pressure of the steam on the piston at the different speeds, we should have been in possession of a test or tie point, which would either have proved or disproved the preceding calculations; but this is a method of keeping accounts (mechanical ones), by *double entry*, which some parties may not approve,

Had the rise of the gradients been uniform, the pressure on the piston, allowing one-third for friction of the engine, would be, up the gradient, 46·5 lbs.; down the gradient, 34·3 lbs.; and on a level railway, it would be 39·7 lbs. With respect to the latter pressure, I will say it is not strictly mathematically correct, in consequence of the actual gradients being a mean and not a uniform rise; and further, that the friction on the axis, arising from the draft of the engine, has not been estimated, but the amount of the two matters mentioned would be very inconsiderable.

According to the theory which I have adopted, the power is somewhat less than 300 horses, and by Mr. Russell's it is somewhat more than 700. The difference is wide enough, and weighty enough, to deserve further inquiry. I say to the shareholders, the life-blood of your purses depends upon it; and if you decline to force the subject on the notice of your directors, the fault is not mine.

I have now reached that point at which it would be proper to show distinctly in what manner a large waste of power, and the same of money, daily and hourly takes place, but I shall wait to see how that which has been already said is received by those who are interested; and if they be lukewarm in the matter, so shall I, who have no interest in it whatever. If they be contented to hold fast by the ordinances enunciated from experiments by the British Association, who have every requisite and means in their power, save that one which no price in money will purchase, I also am content.

JOHN CURR.

SCOTLAND'S SMOKE PROTECTOR.

Smokey chimneys do not appear to be cured yet, if we are to judge of the number of guards and cowls constantly issuing from our inventive workshops. Every possible scheme obtains a trial, and we suspect that smoke preventors find it a much more difficult thing to cure an ill-constructed chimney of the old class, than to provide a remedy in the erection of new ones. With duly proportioned fire-places and flues, this nuisance will utterly disappear, but until more philosophy is exercised in their construction, we must put up with the evil, and apply remedial agents in the shape of external protectors.

Our engravings represent an ingenious contrivance for the purpose, constructed by Mr. Syme of Edinburgh. Fig. 1 is a sectional plan, and fig. 2 a sectional elevation of the protector. The cylindrical case, A,

Fig. 1.

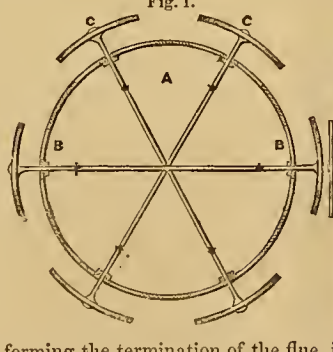
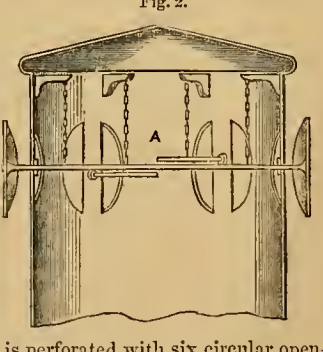


Fig. 2.



forming the termination of the flue, is perforated with six circular openings, B B, forming a ring round its top. Each opening has a valve, C, the whole set being attached to the extremities of three spindles, by chains attached to brackets in the interior of the flue. The slung spindles are independent of each other, and are guided by small bushes in the case, so that, whenever there is any wind, the windward valves are shut, and the corresponding leeward ones opened; but when calm, the suspending chains hang vertically, and every valve is full

open for the escape of smoke on all sides. The top is fitted with a moveable lid for obtaining an entrance into the flue for cleaning or repairing. The plan has an evident advantage in the absence of all minute or intricate movements, and seems to offer a good shield against blow-downs and strong side-winds.

BEAUREGARD'S PATENT STEAM-ENGINE.

[The extraordinary phenomena which form the base of this invention, were first made public in this country by J. E. Bowman, Esq., of Manchester, and doubtless, many of our readers are aware of the brilliant experimental lecture on the subject, given by this gentleman, before the members of the Manchester Royal Institution, in 1845. During a visit to Paris, he witnessed, in the laboratory of Dumas, the origiual experiments of M. Boutigny of Evreux, which he re-produced here, on the occasion to which we have referred, bringing to light many additional facts of value, by his extensive analytical labours. Seizing upon the practical deductions of the theory, M. Beauregard has so far applied them as to have taken out an Euglish patent for the results in July last. The specification of this patent is not yet enrolled, but in the following interesting paper, translated from *La Presse*, will he found the leading heads of the proposed improvement.—Ed. P. M. J.]

The spheroidal state which drops of water assume when placed upon a heated metallic surface, is a fact now well known. Overlooked, or, at best, regarded as a matter of small moment, by the philosophers of the last century, it becomes suddenly, in the hands of M. Boutigny, a circumstance of immense importance,—gives birth to experiments the most singular, the most astonishing, and the most incredible of modern times,—raises up against the admitted theories of heat insurmountable objections, and disconcerts the most advauced science,—accumulates the elements of a new theory,—furnishes the only reasouable explanation of those unforeseen explosions of steam boilers which occasionally spread terror far and wide,—and, lastly, promises to give, in the bold imagination of its author, a key to the impenetrable mystery of the formation of worlds.

We will not undertake, to-day, to describe all these marvels; we will not explain to our readers how M. Boutigny has been able to make ice in the burning bosom of a platina crucible heated to white heat; how, going yet further, the illustrious Faraday, following in the steps of the humble apothecary of Evreux, has succeeded. by the *tours de main* of his prodigious art, in fusing mercury in the same centre of heat, the most intense ever known. We will not narrate how we saw an enormous sphere of incandescent silver preserve for a long time its brightness and great heat in the bosom of a mass of water, which separated respectfully therefrom, and served it as a protecting envelope from cold. We will not enumerate either, the beautiful and numerous laws which years of study and profound research have revealed to M. Boutigny, and which he has clearly formularized. We desire only to fix the attention of the reader on the following remarkable facts:—

1. Water projected in small quantities upon an incandescent surface does not wet it, does not touch it, is not spontaneously vaporized; but, falling back on itself, as it were, it assumes a globular, or, what M. Boutigny terms, a *spheroidal state*, remains suspended at a short distance above, in the incandescent surface, and is slowly reduced to steam—fifty times slower than by boiling.

2. All these phenomena occur as soon as the temperature of the surface of the water reaches 200° (centigrade), and lasts until it decends below 142° (centigrade); the water then wets the surface, and is suddenly and spontaneously reduced to vapour with as much rapidity aud abundance as gunpowder when ignited. For all other liquids, the necessary degree of temperature for the productiou of this phenomenon is as much lower as the boiliug of the liquid is above that of water.

3. Water in the spheroidal state, and then even when in presence of an incandescent surface, does not attain 100° (centigrade), or the boiling point, but invariably remains at about 96° 5′.

Such, in few words, are the fundamental facts demonstrated by M. Boutigny, and which, admirably comprehended by our young engineer (M. Testud de Beauregard), have led him to his present brilliant discovery. We will first faithfully describe the admirable machine which we saw at work yesterday, and afterwards its numerous advantages.

Let the reader place himself, in fancy, in front of a kitchen stove. On the right is a generator—a kind of Papin's inexplosible boiler, plunged iu a *bulneam mariæ*, which is filled, not with water, but with molten lead, at a temperature of about 300° (centigrade). The bottom of the generator is of platina, and so moulded as to present a series of hollow hemispheres. A small feed-pump is placed behind, about the centre of the stove, which discharges at each motion of the piston a small quantity of water (say half a gramme for a machiue of two horse-power) into the cavities of the hemispheres; the water passes into the spheroidal state, and theuce into that of steam. The steam disengaged from the water at 96° 5′ partakes at its generation of the enormous temperature of the generator. This sudden elevation of temperature, produced by itself, without absorption of latent heat, compensates a hundred-fold for the slowness of its generatiou by a considerable increase of tension. A safety-valve, placed iu the centre of the generator, gives free passage to the surplus steam. We shall see further on that explosions are, theoretically and practically, impossible.

A few days longer, and a stationary steam-engine of 10 horse power, fitted with this generator, will be at work in oue of the largest foundries in Belgium. A locomotive on the same principle is also in progress of constructiou; and, by the care of Captain Chamier, a marine engine of 400 horse power will be fitted to one of the largest of the ocean steamers.

To return to our descriptiou: As the steam fills the spheroidal generator, it is conveyed by a steam pipe under the piston of an oscillating cylinder. But instead of allowing the steam to escape into the air after the piston has performed its stroke, and as is usual in high-pressure engines, M. Beauregard causes it to pass through a worm, enveloped in wet cloth, in which it is imperfectly coudensed, after which it is brought, by a new method, into a state of perfect and absolute condensation. Against the back part of the furnace there is placed a cylinder in which a vacuum is created, once for all, in the following manner: The cylinder is closed by a stopper terminating in a metal rod; this rod is dipped in alcohol, then ignited, and plunged into the cylinder, whence the azote of the air is allowed to escape by a cock, which is then closed, and a vacuum thus established. The atmospheric pressure upon the stopper keeps the opening tightly closed, and the vacuum, which costs nothing, is permanently maintained for the following reasons: The steam from the hygrometric water which escaped from condensation in the worm is conducted towards the cylinder by a pipe, but through a second cylinder filled with chloride of calcium, which substance retains it, and does not allow of its entry into the first cylinder, the purpose of the vacuum therein being to create the necessary draft.

From the foregoing description it will be seeu, that the steam is perfectly condeused, and there is nothiug, absolutely nothing, to prevent the fresh emission of steam, and fresh stroke of the piston, &c.

Ah! if old Newcomen were living, of whose grand ideas on the snbject of condensation this is but the realization, he would laugh in his sleeve (*rirait dans sa barbe*)—would glance triumphantly at the Watts and the Woolfs—and chant a pæan of victory.

And yet this is not all: there was yet another difficulty to surmount, another loss to be preveuted. The steam is ouly condensed in the worm on condition of vaporizing without a quantity of water equal to that resulting from the condensatiou of the steam. So that what is gained on one side is lost upon the other. To utilize this steam, M. Beauregard brings it, by means of a draft or current of air, into the furnace of the generator, where the heat decomposes and transforms it into hydrogen and carbonic oxide, two combustible gases which, in burning, transform themselves, so to speak, first into heat, then into vapour, and ultimately into motive power. The loss no longer exists, or is considerably diminished, and the machine is in its entirety as perfect as can be any work of man.

The following are the chief characteristics of this machine:—

1. The water which falls in small quantities into the hemispherical cavities of the generator, passes into the spheroidal state, and then slowly into steam of a high temperature, which slowness of gcneration is amply compensated for by an excess of elastic force which will be sufficieut for the working of the most powerful engines.

2. The steam thus generated passes under the piston and forces it up; after the stroke is made, the piston by its descent expels the steam into a worm, where it is partly condensed by contact with a refrigerating surface,

3. What remains of hygrometric steam is forcibly drawn towards the vacuum cylinder, and absorbed half way by the chloride of calcium—which may be revivified by the simple and costless procceding of exposing it to the heat of the furnace for a sufficient length of time.

4. The steam generated on the exterior surface of the worm is forcibly drawn into the furnace, which it serves to feed. The circle of operation is theu complete.

The only actual loss is the heat radiated by the sides of the furnaces, which M. Beauregard collects by a combination of reflectiug surfaces to wherever it may be useful.

The admirable machine, which we saw at work for an hour, scarcely

occnpied the space of half a metre cube, while the steam generator, which in ordinary machines would require 1800 decimetres, occupied a space 300 times less, and yet the power, as calculated by the inventor, was two horse-power, and the pressure (tension) of the steam capable of being raised without the shadow of danger, from one to five or six atmospheres.

These astonishing results were obtained with a minimum quantity of coal, and all those present at the experiment admitted that the results were quite at variance with all old theories and axioms.

In conclusion, we will terminate this long article by a brief notice of the incontestable advantages of this machine.

1. In the old engine there is an enormous radiating surface, and conseqnently an immense loss of heat. In the new one this surface is rednced in the proportion of 1 to 100; the furnace is small, and loss of heat insensible.

2. In the old engine the steam is generated at 120° (at sea 105°) at a very feeble pressure, at the most one atmosphere, and capable of dynamic effect to the extent of about three. In the new one the steam is generated at 96° 5′, its pressure is 200 atmospheres and without danger, and the dynamic effect is at least 14.

3. In old low-pressure engines the condensation was incomplete; a considerable portion of its power was employed to overcome the resistance of the used steam. In the new one the condensation is nearly absolute, and the maximum of nsefnl effect constantly obtained.

4. In the old engines, the feed-water is charged with salts. The condensation necessitates the employment of an immense quantity of water —so mnch so, that at sea they are often obliged to blow off, with loss, water at 100°, hecause it is too saturated with salts. In the new one, the generator is fed with distilled water. The condensation is effected without any additional supply of water. There is never any necessity to renew the water which, running through the different parts of the machine, gives life to it, because this water, alternately vaporized and condensed, reappears of itself, abundant and pure.

5. In the old engine, loss of time throngh stoppages is loss of money. The locomotives are often obliged to blow off the steam, which costs much to generate, hnt which they could no longer contain without danger. In the new one, there is never a mass of water heated a long time beforehand—no tempestuons prodnction or accumulation of steam—no fuel vainly consnmed in anticipation of a journey; it is necessary only to maintain a small quantity of lead in a fluid state.

ANATOMY OF THE PHYSICAL STRUCTURE OF THE UNIVERSE.

By Mr. R. Smith, Blackford.

VI.—Light.

Long before the discovery of polarized light, Hnyghens observed the colonrs in Iceland spar, hut of their origin and nature nothing was known. In 1813, Sir David Brewster discovered the systems of rings round the axis of donble refraction, when two prisms, whose refracting angles are abont 45°, are cemented npon the under and npper snrfaces of a rhomb of Iceland spar, and placed upon the stage of the apparatus, so that the polarized ray passes throngh the crystal in the direction of its axis. On looking into the analyzing plate, there will be seen a system of elegant coloured rings, intersected by a black cross. By turning the spar round npon the stage, no change whatever takes place in the appearance of the rings. When the analyzing plate is made to revolve round the ray, at the angles of 0°, 90°, 180°, 270°, the same system of rings is observed; bnt at the angles of 45°, 135°, 225°, and 315°, another system of rings appears complementary to the former, intersected by a white cross. In regard to the form and number of them, both systems of rings are the same, conseqnently the superposition of the two systems would obliterate both, provided that this could be accomplished. The phenomena may be seen with the same advantage hy cntting off the angles where the prisms are placed, perpendicnlar to the axis of the spar, and polishing the surface of the faces, instead of making use of the prisms. If other crystallized bodies, which contain one axis of double refraction, he examined in the same way, it will be discovered that all of them produce a system of rings analogous to those of Iceland spar. The following is a list of crystals that produce a negative system of rings:—

- Alnnite.
- Arseniate of Lead.
- Arseniate of Copper.
- Arseniate of Potash.
- Beryl.
- Carbonate of Lime.
- Carbonate of Lime and Magnesia.
- Carbonate of Lime and Iron.
- Carbonate of Zinc.
- Cyanurate of Mercury.
- Corundum.
- Edingtonite.
- Emerald.
- Gmilinite.
- Hyposulphate of Lime.
- Hydrate of Strontium.
- Idocrase.
- Levyne.
- Mica from Kariat.
- Muriate of Lime.
- Muriate of Strontium.
- Molybdate of Lead.
- Mellite.
- Nepheline.
- Nitrate of Soda.
- Octohedrite.
- Oxahverite.
- Phosphate of Lime.
- Phosphate of Lead.
- Phosphato-Arseniate of Lead.
- Phosphate of Ammonia and Magnesia.
- Paranthine.
- Ruby Silver.
- Ruby.
- Rubellite.
- Somervillito.
- Sapphire.
- Sulphate of Nickel and Copper.
- Subphosphate of Potash.
- Tourmaline.
- Wernerite.

When a system of rings, formed by a crystal of the negative class, such as Iceland spar, are combined with a system of the same size, produced by a crystal of the positive class, as quartz or zircon, they obliterate or destroy each other; hence the system of rings formed hy the quartz or zircon is positive, or possessing properties opposed to those of the negative, produced by Iceland spar. List of crystals that give a positive system of rings:—

- Apophyllite.
- Boracite.
- Dioptase.
- Hydrate of Magnesia.
- Ice.
- Oxide of Tin.
- Ferro-cyanate of Potash, certain specimens.
- Quartz.
- Sulphate of Potash aud Iron.
- Superacetate of Copper and Lime.
- Tungstate of Lime.
- Titanite.
- Zircon.

In 1817, Sir David Brewster discovered a double system of rings in topaz, the colours of which are exceedingly bright and beautiful. In order to exhibit this phenomenon, a plate of topaz is formed by splitting a piece of the mineral perpendicular to the axis of the crystal, and placing it upon the stage of the apparatus. A double system of coloured rings may be seen more advantageously by using a plate of nitrate of potass, instead of topaz. The latter were likewise discovered by Sir David Brewster a short time after the discovery of those in topaz. A plate of nitrate of potass is easily prepared for this purpose, by cutting a small piece from the end of the crystal, and grinding it down to about the one-eighth of an inch in thickness, and cementing it between two pieces of glass, by means of Canada balsam. When the plate of nitrate of potass (thus prepared) is laid upon the stage of the polariscope, in such a position that the plane of its axis shall be perpendicular to the plane of primitive polarization, a beautiful system of rings, intersected by a black cross, will be seen in the analyzing plate. If the plate of nitrate of potass is turned round its axis upon the stage, beginning at 0°, the black cross will open at the centre, and will be divided into two curves. As the plate moves round, the curves will continue to recede from each other till the plate has reached 45°, when they will appear in the form of two hyperbolic curves. If the revolution of the plate be continued, the system of rings with the black cross will be seen at the azimuths 90°, 180°, and 270°, while the two hyperbolic curves will appear at the azimuths 135°, 225°, and 315°; but during the whole revolution of the plate, the colours and form of the system of rings undergo no change. However, if we turn round the analyzing plate, and allow the plate of nitrate of potass to remain fixed at 0° or 90°, there will be observed at the angles of revolution of 90°, 180°, and 270°, a complementary system of rings, with the black cross changed to a white. On examination, it will be found that the colours of the double system of rings are nearly the same as those of Newton's table, the zero of the various orders of colours commencing at the centres or poles. It is only when we use thin plates that the above holds good, for if a plate of considerable thickness is employed, the colours of the rings lose their resemblance to those of Newton's table very considerably. By means of the oxy-hydrogen light, and a polarizing apparatus fitted up with lenses, for transmitting the polarized light to a white disc, we obtain images similar to those exhibited by the oxy-hydrogen microscope. When the experiments which we have described in this paper are performed with this kind of polariscope, the magnified representations are amongst the most beautiful and magnificent to be found in the extended field of experimental science.

The phenomena of polarized light, like those of ordinary reflection and refraction, are governed by certain laws; and these laws are in constant

operation in the economy of the universe, causing various effects, which produce beauty, harmony, and order throughout the ever-changiug scenes of nature—in the reflected light of the sun, moon, and stars, and in the colours of all the varieties of clouds. The author is of opiuion that a considerable amount of the variation of colour is caused by the effect of polarized light, although aware, at the same time, that this idea is at variauce with the generally received opiniou, that the effect in question is produced by ordinary refraction and reflection. It has been formerly mentioned, that the light reflected from the sky is preferable to any other kind for the development of colours with the polariscope; consequently, if the light reflected from the bright part of the sky, immediately above the place where the sun sets, falls upon a portion of the earth's surface at an angle of 45°, a part of the light reflected from the earth to the clouds will be polarized, so that, wheu the clouds are in such a position as to receive the polarized light from the earth, we can easily perceive that a phenomenon, similar to that occasioned by breathing upon the analyzing plate of the polariscope, will occur when the index is placed at 45°, that being the polarizing angle for water. Hence, a play of colours upon the under surface of the clouds will take place analogous to the tints upon the analyzing plate, explained in the last paper. Or, in the same way, one tier of clouds will polarize the light, and another tier analyse or develop the tints, and continually shifting their positions and forms, producing a change of forms, colours, and tints, till the gloaming grey is sunk in the dusk of eve; or, if in the morning, till the aurora's feeble rays are mingled with the brilliant light of the blazing day.

Although the ancient philosophers were acquainted with many of the physical properties of light, it does not appear that they were practically conversant with its chemical actions. The only facts which we find recorded by them relative to this subject, is the influence of light on some of the precious stones, such as opal and amethyst; when they were exposed for a considerable time to the direct rays of the sun, their brilliancy was greatly diminished. It is said that the Indian jugglers were at one time acquainted with a method, or process, by which they could take a profile portrait of any individual by the action of light. Be this as it may, there is now no such process known amongst them. The alchemists discovered that the white colour of the chlorate of silver was changed to black, when exposed to light; but it is to Sheele that we are indebted for the first philosophical description of this curious property of the salts of silver, and also for the knowledge that the different coloured rays possess different powers in producing this change; and Ritter, in 1801, detected rays beyond the visible spectrum, which were as effectual in blackening the salts of silver as those of the spectrum. Next in order, followed a host of philosophers, amongst which were M. Berard, Berthollet, and Sir William Herschel, who described the luminous, calorific, and chemical actions of the different rays. Dr. Wollaston, in a series of experiments which he made on the effect of light on gum guaiacum, found that a paper wet in a solution of the gum in alcohol, was changed from a yellow colour to a green when placed in the violet rays, while the red rays again restored the green colour to its original yellow tint. By means of a number of experiments, Sir Humphrey Davy ascertained the following facts: that hydrogen and chlorine gases combine more quickly in the red rays, than they do in the violet; that oxide of mercury is not altered in the most refrangible rays, but is rapidly changed in the least refrangible to a red colour; and when moistened puce-coloured oxide of lead was exposed to the action of the red rays it became red, and when exposed to the violet rays it became black. Count Rumford discovered that metallic gold and silver could be revived from their oxides by the action of the sun's rays. No doubt those experiments in a great measure paved the way to the art of photographic drawing, but no attempts were made to delineate objects by light till 1802, when Mr. Wedgewood copied, on glass, paintings with paper prepared with chlorate of silver; and Sir Humphrey Davy, in the following year, formed the images of minute objects, produced by means of the solar microscope, upon paper washed with a solution of nitrate of silver. M. Niepce, it appears, was the next person who directed attention to the production of pictures by the rays of light. He commenced his inquiries in the year 1814. His process is called heliography, which means, pencilled by the sun, and consists in dissolving asphaltum in oil of lavender, and spreading it over plates of glass, copper, or silver: this preparation is by no means sensitive, and of course has been long given up except in a philosophical point of view.

In the month of January, 1839, Mr. Fox Talbot communicated to the Royal Society his discoveries on photography; but the most important discovery made by this eminent philosopher was published to the world in the mouth following, and is called the calotype (the beautiful), and more recently the talbotype, after the name of its discoverer. To prepare the calotype photographic paper, Mr. Fox Talbot recommends a solution of 100 grains of nitrate of silver in six ounces of distilled water; the one side of the paper is brushed over with this solution, and allowed to dry spontaneously in a dark place; it is then dipped in a solution of iodide of potassium, containing 500 grains of the salt dissolved in one pint of water, and is then washed in pure water and dried—the paper thus prepared is called iodized. To render this paper sensitive, it is washed over with what is called the gallo-nitrate of silver solution. To prepare this solution, 100 grains of nitrate of silver are dissolved in two ounces of distilled water, and one-sixth part of strong acetic acid added to it; then take about two ounces of distilled water, and add to it as much gallic acid as it will dissolve. Now, take equal volumes of the gallic acid solution, and the above nitro-acetic of silver solution, and mix them together; the iodized paper is then quickly washed over with it, when it is ready for being placed in the camera: this paper is exceedingly sensitive, only requiring a very few seconds of exposure to the actiou of the light to obtain the impression. After the paper is taken from the camera, there is scarcely any image visible, but when it is washed over with the above gallo-nitrate of silver solution, and gently warmed, the picture appears with all its beauty and vivacity. In order to fix the picture thus obtained, the superfluous moisture is removed by means of blotting paper, and it is then washed in a solution of bromide of potassium, containing 100 grains of the salt dissolved in 10 ounces of water; it is then washed with pure water, and finally dried. The picture produced by this process is what is called negative, having its lights and shades reversed; and in order to obtain a positive image, one which has its lights represented by lights, and the shades by shades, conformable to nature, a paper is first washed over with a solution of bromide of potassium, prepared by dissolving 100 grains of the bromide salt in one ounce of distilled water, and when dry is again brushed over with a solution of nitrate of silver, containiuig 100 grains of the nitrate of silver in an ounce of distilled water; when the paper is dry, it is placed upon a smooth board, and the negative picture of the former process is laid upon it, and a plate of glass above, the whole being pressed together by means of screws. After being exposed to the light for a minute or two, an image is formed upon the second paper; the image upon the copying paper will be faint, but may be made bright by washing it over with the gallo-nitrate of silver, and then fixing it in the same manner as that of the negative one. About five months after Mr. Fox Talbot communicated his discovery of the calotype, the daguerreotype process made its appearance. The French government awarded to M. Daguerre, and his partner M. Niepce, a divided annuity of 10,000 francs (£416 13s. 4d.) for the process of photographic drawing, termed the daguerreotype. M. Niepce, sen., father of the above-mentioned M. Niepce, and M. Daguerre, entered into partnership, in order to prosecute in common their photographic experiments. So late as 1829, and at the death of M. Niepce, sen., in 1833, the connection was kept up by his son, notwithstanding the discovery of the daguerreotype process was the result of the single and unaided labours of M. Daguerre.

The daguerreotype process consists of five operations. The designs are executed upon thin plates of silver, plated upon copper: the plate must be polished to a perfect smoothness with olive oil, and finely-powdered pumicestone, or tripoli, and finely-carded cotton, and then washed with nitric acid; it is then cleaned off with dry cotton and a little of the polishing powder, and is placed upon a wire-frame with the silver face upwards, and the flame of a spirit lamp is made to play upon the copper below, continually moving about the lamp so as to heat the plate equally; as soon as a white coating is formed all over the surface of the silver, it is removed from the wire-frame, and cooled upon a marble slab, after which it is again polished with the polishing powder and dry cotton; the acid must again be applied in the same manner as formerly directed, two or three times, each time rubbing it with the polishing powder and the dry cotton. The plate is then placed in the upper part of a box, supported by side catches, face downwards; at the bottom of the box is placed a saucer containing iodine; when the plate assumes a golden tinge, it must be removed from the box, and kept in the dark until ready for the camera. The focus of the camera being adjusted, the plate is quickly placed in its position, and allowed to remain for the space of twenty minutes, at the end of which time it is taken from the camera, and placed in another box at an angle of 45°; at the bottom of the box is placed an iron or porcelain cup containing mercury, and the flame of a spirit lamp is applied to the bottom of the cup till the temperature of the mercury rises to 140° Fahrenheit; the lamp is then withdrawn. The temperature of the mercury will continue to rise without the aid of the lamp to about 167° Fahrenheit; when this operation is completed, the impress of nature in all its beauty will appear upon the tablet or plate. To fix the impression, the plate is placed in a basin of water, plunging and withdrawing it two or three times; it is then placed in a weak solution of hyposulphate of soda, till the yellow tinge of the plate disappears; it

is afterwards placed on an inclined plane, and distilled water is poured over it in a continuous stream, and if any drops remain on the plate after the operation, they must be removed by blowing upon the plate, or by shaking it until they fall to the under edge, when they may be removed by blotting paper. M. Barnard considerably improved the method of M. Daguerre, by chlorizing the plates. A plate, after being iodized in the above manner, is placed in a vessel of chlorine gas diluted with common air to such a degree, that it may be inhaled without any unpleasant sensation; after the plate has remained exposed to the action of the chlorine for half a minute, it is withdrawn, and will be found to be so sensitive, that the exposure of the plate in the camera is reduced from twenty minutes to a few seconds.

Since the discoveries of M. Daguerre, numerous improvements have been introduced into the dagnerreotype process, and every professor of the art appears to have his own method, so that it is difficult to ascertain which is the easiest or best. M. Seguier states that a single polishing with tripoli, moistened with acidulated water, is sufficient to cleanse the plate, which of course simplifies the polishing operation to a great extent. A very excellent and easy method of giving the plate the sensitive coating is as follows: cover a card of cotton with iodine, perfectly dry, and hold the plate over it; as soon as it has acquired the yellow tint, a single drop of bromine is put into a capsule, and placed in a box, in which the iodized plate is put; in a few seconds the plate will assume a rose colonred tint, and must be taken from the box, this tint being the most sensitive coating. Another liquid is prepared by adding twenty drops of bromine to half an ounce of liquid chlorine; the mixture must be kept in a bottle with a ground glass stopper, and when required for use, a drop or two is placed in a capsule, and applied in the same way as that of pure bromine in the former method. Instead of the card of cotton, a board of soft wood saturated with the tincture of iodine, and placed in the box, will answer the purpose for coating the plate with iodine. A plate of glass, ground on one side to roughen the surface, may be substituted for the board for iodizing the plate, and this is well adapted for the following method which the author devised: ten grains of iodide of potassium are dissolved in an ounce of distilled water, and as much iodine is added to the solution as it will dissolve; a small quantity of the mixture is then spread over the ground side of the glass, and the plate to be iodized is held with the hand over the mixture upon the glass, at the distance of half an inch, and in a very short time the plate will be covered with the golden tinge; then hold it over the chloro-bromine liquid described above, for a few seconds, when it will acquire the rose colour, and is ready for being placed in the camera.

The operation of bringing out pictures may be performed without the aid of a mercurial box, by substituting for it a common basin and sand-bath. Place the sand-bath upon a charcoal fire, and put the bottom of the basin upon the sand; then place a small piece of wood, about an inch in height, in the bottom of the basin at the one side, and pour a quantity of mercury into the basin also; in which place a thermometer; then take the frame containing the plate, and place the one end of it upon the piece of wood, and the other end near the top of the basin, on the opposite side, so that the plate may be placed over the mercury; a piece of mill or deal board is laid over the basin, to prevent the escape of the mercurial vapour. As soon as the thermometer indicates 140°, the basin is removed from the sand-bath, and by edging up the board and plate-frame at intervals, the progress of the development of the impression may be observed. Instead of the vapour of mercury, the image on a daguerreotype plate may be brought out, by placing over the plate a red or yellow glass, and submitting it to the rays of light. This interesting experiment was first shown to the world by MM. E. Becquerel and Gandin. However, it is scarcely so good a method as that of applying mercurial vapour.

The following method of fixing the images of the daguerreotype is that of M. H. Fizeau, and is a very excellent one: Dissolve 15 grains of the chloride of gold in a pint of distilled water, and dissolve 45 grains of hyposulphate of soda in another pint of pure water; pour the chloride of gold solution into that of the hyposulphate, stirring it briskly during the time of mixing; the mixed liquids are first yellow and then limpid. After the plate has undergone the mercurial operation, it is dipped in alcohol and water, and then placed upon an iron frame, and covered over with the above mixture. Heat is then applied to the under surface of the plate, by means of a large spirit lamp or a charcoal fire; when the impression becomes quite clear, the liquid is poured off, and the plate is washed and dried, when the image will appear exceedingly beautiful. In the next paper we shall give a description of the other photographic processes of consequence, including the Chrysotype, Ferrotype, Anthotype, Energiatype, Prussiatype, Uritype, Astrotype, and others.

PRACTICAL NOTES.

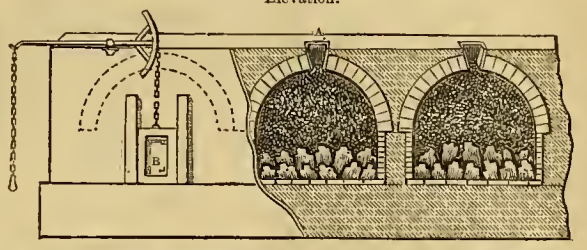
THE MANUFACTURE OF COKE.

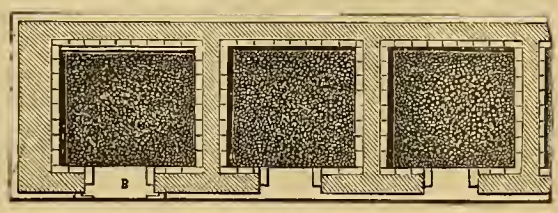
[Concluded from Page 170.]

The superior economy of the furnace system of coking, when carried out on a large scale, has led to its universal adoption by railway companies, and other extensive manufacturers; and, consequently, the mound process has of late years been disregarded. Figs. 1 and 2 of our engravings, represent the principal arrangement which has found favour at the ironworks of this country. In order to economise both brickwork and heat, several furnaces are built together; in this case there are four, the last one being broken away in our view. Each furnace is a rectangular space with an arched top, its dimensions being 10 feet from front to back, 12 feet wide, and 10 feet high. The linings are of firebrick,

Fig. 1.

Elevation.





Plan.

Fig. 2.

the whole thickness of the walls being 2 feet. In the centre of the arched top, an aperture, A, 2 feet 6 inches wide, is formed, and fitted with a metal ring; this opening answers as a passage for the draught current of the fire. The end furnace, shown in elevation, exhibits the kind of fire-door employed. The door, B, is an open iron frame, filled in with brickwork, and adjusted to slide in a grooved metal guide on each side, the whole being suspended by a chain, from a segmental lever carried on a stud on the top of the furnace wall, with a chain attached to the contrary end, for setting the door at any required position. The brickwork of the door is generally provided with a series of small openings for the admission of air to the interior; this being the only air passage, as no grate bars are used.

In charging, about two tons of coal are introduced by the door, B, the heap just reaching to the spring of the arched top, thus leaving space for swelling. As the furnaces are kept in constant action, day and night, they are always in a red-hot state, therefore the new charge of coal immediately ignites from the heat radiated from the walls, and the combustion is urged on by the rush of air through the apertures in the door. In about three hours after charging, the heat becomes so great, that the feed of air is to be diminished, by closing some of the lower apertures, according as it is desired to moderate the intensity of the action of the fire. Nothing further is then done, until the expiration of 24 hours from the beginning of the process, when the upper draught holes in the door are stopped, and the furnace stands for 12 hours with the top-opening, A, uncovered, to allow of the passing off of the remaining gases and vapours in the form of flame. When this discharge ceases, the opening, A, is covered with a metal lid, or with stones covered by a layer of sand, for the purpose of still further moderating the heat during the succeeding 12 hours, when the operation is complete; 48 hours having expired since the initial charge. The interior of the furnace, and the coke, is still red hot, but, owing to the slight combustibility of the latter, the door may be opened, and the coke drawn out with rakes, and quenched with water, without loss. A fresh charge of coal is then introduced as quickly as possible, to render available the former heat; and it is always arranged so that the labour may be equally divided over a given space of time, by drawing off one furnace, during the actual coking of its neighbour.

The most important improvement in furnace coking, which has taken place for some years, is that of Mr. Church of Colchester. By a superior construction of furnace, as well as by various modifications in the operative details of the process, this gentleman has succeeded in producing a coke of great purity and density, and possessing heating powers very far exceeding those of the ordinary furnace coke. One great source of waste in coke of the usual friable character, results from the great amount of dust formed from it, which is almost incombustible; and in addition to this evil, loss ensues from the action of the blast carrying off a quantity of the smaller fragments unconsumed.

The furnace employed by Mr. Church is shown in front elevation in fig. 3; fig. 4 is a corresponding side view, and fig. 5 is a horizontal section, just above the floor of the furnace. The erection is circular, with a flat arched top; A, is the metal mouth-piece of the oven, or furnace, within which a temporary wall of bricks, B, is erected in front of the coals, as they are thrown in. A cast-iron door, C, is fitted to the mouth-piece, and has a number of vertical slots for the admission of air to the interior; slides being provided for the closing of these openings when required. Two additional passages are made at D, D, in the side walls, and carried in an upwardly inclined direction, towards the interior of the oven, so that the air supplied in this manner may not impinge directly upon the surface of the charge of coal. E, Is the chimney, placed at the back of the oven, with a flue leading into it from the back wall. F, F, Are two openings, through which, after the charge has become carbonised, cold air is introduced for the purpose of cooling it down, valves being fitted for the due regulation of the admission of air, which passes along the bottom passages, G, communicating with each other by the small vertical passages, H. The horizontal passages, G, pass underneath, and round the whole of the bottom of the oven, but do not in any way communicate with the interior. Two vertical pipes, J, J, are placed on the top of the oven, and are fitted with covers for the discharge, when necessary, of the air employed in cooling the coke. The portions of the oven, between the external walls and the cooling passages, are filled up with concrete, as at K, K.

Fig. 3.

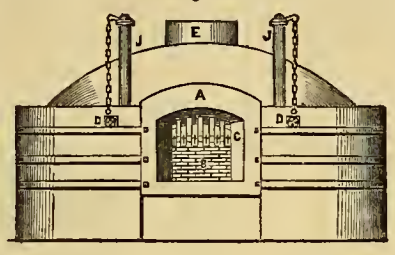


Fig. 4.

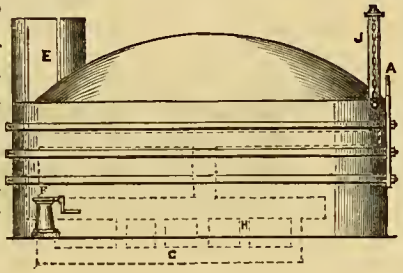
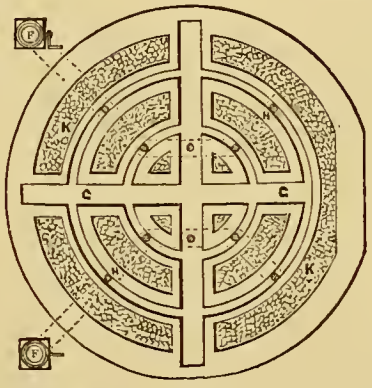


Fig. 5.

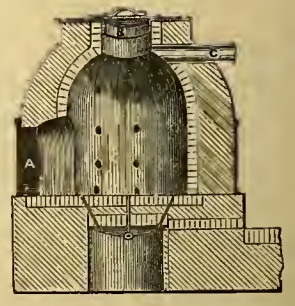


In putting this oven in action, a quantity of coal is thrown in sufficient to cover the floor of the oven to the depth of about two feet, and spread so as to present an even surface at the top, with the exception only, that the mass is made to incline a little from the front and sides towards the middle. As the oven is being charged with coal, the wall of brickwork, B, is gradually built up in front; a shovelful of burning coal is then thrown in at top, and as soon as the main body of coal has become fairly ignited, the oven-door or "regulator," C, is closed, and the edges of it next the mouth-piece, as also all the joints of the temporary brickwork, are well luted. The passages in the door, through which the air necessary for the support of combustion is supplied, are in the first instance left entirely open, the passages, G, H, employed in the cooling-down process, being at the same time entirely closed. But according as the coking of the coal advances, the passages in the door are gradually closed by means of the slides, till at length, on the conclusion of the process, of which the cessation of all flame on the surface of the coke may be taken as a good practical criterion, they are wholly shut. The valves on the openings, F, F, are then opened for the admission of air to cool down the coke, and the caps of the exit pipes, J, J, are pulled off; and not till the coke has been thoroughly cooled, is it removed from the oven. The ordinary process of withdrawing the coke from the ovens in a hot state, and then throwing cold water upon it, is thus entirely superseded. The coke produced by this new process of manufacture is of a very superior quality, and the quantity produced from a given quantity of coal is also much greater than usual. The time ordinarily employed in carbonising or coking eight tons of coal, including the time occupied in the cooling process, varies from 80 to 90 hours, according to the quality of the coal employed, and the temperature of the atmosphere at the time. When it is desired to obtain a coke more than usually free from sulphur and other metallic admixtures, the coal is further subjected, at completion of the process of carbonisation, to the action of a current of electricity. As soon as the flame on the surface of the ignited mass of coal begins to die away, the apertures in the door are closed, as beforementioned; an iron rod is then introduced through the temporary brickwork into the coke near the bottom; and through the back of the oven, just under the chimney flue, a second rod is passed over the surface of the coke, so that it shall rest upon, and be in a state of perfect contact with it. The former rod is connected with the positive pole of a powerful electric battery, and the latter with the negative pole, each by means of a stout copper wire, leaving the body of coke in the oven to complete the electric circuit. Care is, of course, taken that the iron rods and connecting wires shall be completely insulated from all substances of a nature calculated to divert or intercept the electric current. Supposing the mass of coke to amount to about six tons, it is found in practice that the time to which it may be beneficially subjected to the electric action is about two hours. On repeatedly analyzing equal portions of coke made from the same description of coal, one of which has been subjected to the electric action, and the other not, the former is shown to be freer from sulphur and other metallic admixtures in the proportion of about 12 to 1.

The greatest point of novelty in this process, is the perfect cooling of the coke previous to its removal from the oven, without watering, and in this respect the plan possesses an immense superiority over all other arrangements. Drivers of locomotive engines, who are, perhaps, the best judges of what good coke should be, state that Mr. Church's production clinkers only in a very slight degree, and leaves little or no corrosive matter in the tubes or fire-box.

In many localities, the collection of tar during the coking process is of great importance, and for this purpose, furnaces are specially erected for its economical production. Fig. 6 represents a brick furnace of this class, used in Silesia, a country where tar forms a valuable item of commerce. It is cylindrical, with an arched top, and stands eight feet in height. A, Is the chargiug opening, which is filled up with dry bricks after the supply of coal is put in, and an external iron door, luted round the sides, secures it air-tight. In charging, large masses of coal are first introduced at A, leaving a space for the insertion of burning coals; afterwards, smaller pieces are dropped through the upper opening, B, making the total supply from 35 to 40 cwts. The air has access by a series of small apertures in the walls, the lowest row of which holes is in the sole of the furnace itself. In this way the sole becomes a species of grate, being built over a cylindrical hollow in the foundation. In some furnaces, however, the sole is quite solid, and the draught holes commence only at its level.

Fig. 6.



When the first deposit of coal has taken fire, the two main openings, together with the upper rows of draught holes, are closed; and when the fire, as observed through the open bottom row, assumes a reddish-yellow colour, those of the bottom row are closed, and the second one opened.

The first series is generally closed after 10 hours, the second being opened for the same time; the third, 16 hours; and the last, 3 hours; after which, nothing is done for 12 hours, when the coke is drawn. During the operation, the tar vapours are carried off by the upper horizontal passage, C, in the side of the arched roof, to a cistern where they are condensed. With four such furnaces, eight burnings are made per week.

Late discoveries have thrown a good deal of light on the subject of the composition and general properties of coke, and, in connection with one of the most singular of these, we may refer the reader to page 118, *ante*, for some remarks by Dr. Faraday, upon the "Conversion of Diamond into Coke, by M. Jacqnelain;" and also to Mr. Nasmyth's discovery of "a peculiar property of coke," at page 163. The peculiar hardness of the minnte particles of coke therein detailed, will shortly be turned to account in a great variety of manufactures; and as one result of the discovery, known long previons to the publication of Mr. Nasmyth's experiments, we may mention the celebrated razor sharpening "diamond dust," which appears to possess a nearer relationship to pulverised coke, than to the gem to whose name it aspires.

THE LIFE AND CHARACTER OF GEORGE STEPHENSON.

By J. Scott Russell, Esq.

It will be recorded, that about the middle of the nineteenth century locomotives first began to run upon railways, and that George Stephenson, the president of the Institution of Mechanical Engineers, was the man to whose original genius chiefly, the world was indebted for the discovery. It is difficult for us, to whom the terms railway and locomotive are household words—to ns who live, move, and have our being, among railways and their manifold social results—to go back again, even in imagination, to the beginning of the last twenty years when we were withont them. So fast, indeed, we may be said to have lived through those twenty years; so much we have been able to travel over, and see, and learn, and do, that it seems longer to go back over these twenty years, than over centuries of tbe slower times that went before. We, who have each of us this day come onr hnndreds of miles to this meeting,* and may still have to return hundreds of miles to our homes this night, will find it hard to believe in the records of perils, privations, and delays, which, hnt a few years ago, made a journey from Newcastle to Birmingham one of those serious undertakings of life which were anticipated with apprehension, and recollected with congratulation. We now do more work, and see more society, acquire more knowledge, hy personal observation, in one day of railway life, than we were wont to do in weeks of "the good old time." It will be necessary, however, to task our imaginations, and go back to the times before Stephenson, in order duly to appreciate the full valne of the benefits whicb his labours have conferred npon ns.

It is not, however, alone, with what George Stephenson *did* that we are concerned; still more important it is for ns to consider what George Stephenson *was*. His title to onr gratitude is no doubt great; but his claim to our admiration, as a man, is still greater. As a plain labouring workman, we first find him distinguished by his untiring industry, by his zeal for the interests of his employers, and by his steadiness, sobriety, and honesty. We next find him, after having mastered all the details and drudgery of his business, continually on tbe watch for improvements, cultivating habits of aecurate observation, and spending every leisure moment in classifying and comparing the results of his own observation, and in dednoing from them hints for future improvement. Did an accident occur in his mine, his whole thoughts were immediately directed to the means of preventing its recurrence. His business, in the humble capacity of a hrcaksman, took him casually to the vicinity of a condensing steam-engine, where the property of his master, through ignorance and mismanagement, was in danger of suffering serious damage. The young breaksman had already carefully studied the nature of its parts, and thonght over the prineiples of its construction; the regular engineer had been baffled in his remedies, and despaired of a cnre; but the youthful breaksman confided in the strength of his conviction, and boldly undertook the task of refitting the machine: the stuhhorn engine became at once, in his hands, obedient and useful; he had discovered for himself the secrets of the steam-engine; and at five-and-twenty the young coal-worker had become a mechanical engineer.

Thns early were the results of his self-education manifest. He had mastered the discoveries of Watt. It is trne, indeed, his whole life had been one of discovery; bnt as yet he had discovered no morc than tbose who had gone before him. His had heen the best of all education,—the edncation which a truth-loving mind, working its way among dead matter, and wrestling with the laws of nature, receives directly from nature herself,—an education far more profound and prolifc than words, books, or lectnres can ever impart. He had learned the laws of nature at first hand, and by experience; he knew partially what the true properties of matter were; he felt tbat what they were, was exactly what they ought to have been; and however indefinitively he might he able to give reasons to others for his belief, yet one of the most valuable results of his practical self-education was to give him that implicit confidence in his own right understanding of nature, which carried him so holdly through the herculean undertakings of his future life. The whole first years of his early life were, in this way, one continued chain of discovery. Who can tell the pleasure, or weigh the profit, which such an education hestows on the simple and correct student,—compared to the formality of written dissertations, and the dryness of second-hand knowledge?

As yet, we have said he discovered nothing new; hut he was now on the eve of making a discovery, the reputation of which has ennobled the name of one of our greatest chemical philosophers. A mechanic, James Watt, had already anticipated the philosophers Cavendish and Lavoisier in the analysis of water; and another was now about to anticipate Sir Humphrey Davy in the invention of the safety-lamp.

That Stephenson was the original inventor of the safety-lamp is now happily beyond doubt. Like most other inventions which seem to make their appearauce in several places simultaneously, at the moment when the want of them has come to he deeply and generally felt, tbe safety-lamp seems to have started into being nearly at the same moment in London and Newcastle. Stephenson and Davy had both discovered the principle ou which they proposed to proceed, before either had made the lamp; *but Stephenson's was made and used the first.* That Stepheuson first invented the lamp admits of no doubt, however much the question may remain as to how far Davy may not also be entitled to the merit of equal originality: priority to Stephensou uo one can justly lay claim.

It is as a professional engineer and a practical mechanic that we here have chiefly intrusted to us to do justice to the memory of our distinguished president. But we shonld do violent iujustice to our own feelings, if we were to pass altogether without notice his social character and private life. It is well for us all to recollect, that mere eminencc as mechanics, or mechanical inventors, is not enough in the social world to make us either command the love or respect of our fellows. It is as men, chiefly, that we respect one another; it is moral character aud social virtue for which we chiefly love each other. It has, indeed, been remarked by some, on the character of our profession, that the continual struggle with tough, hard, and refractory substances, which form the business of the engineer, has the effect of communicating a hardness of character, an obstinacy of disposition, and a rigidity of temper, to men of our craft, which does not add to their excellence as members of society. It must be remembered, however, as a palliative for such faults, where they exist, that every inventor is at first in a minority of one; all the rest of the world is, for the time, against him; and it is often only by a long and hard fight that he at last succeeds in convertiug his minority into a majority.

Invention is, therefore, a battle with the world; and it is not always easy for the inventor again to consider with complacency his enemies in the field, and to adopt them as his companions in the closet. The antagonism between the inventive man and the sceptical world is apt to extend itself to the social state. But Stephenson was, happily for himself and the world, a man endowed with no common share of the feelings which make the intercourse of life useful to himself and delightful to his friends. His energies had been sufficient to carry him through much opposition without cooling the ardour of his affections, originally warm and genial, and, above all, without chilling the euthusiasm, or closing the openness of disposition, which characterized the sanguine youth. In his latter days he was distinguished for the childlike simplicity of his character, for the transparency of his intentions, for the singleness of his purposes, and for the straightforward manly honesty of his conversation and dealings. If he could hate an enemy, he never masked his antipathy hy hypocrisy; but he was a warm and earnest friend.

Greatly, however, as Stephenson's name will continue to be distinguished among us as the inventor of the safety-lamp, and as a youthful mechanic of wonderful shrewdness and sagacity, it is as the first constructor and chief inventor of locomotives and railways that he will he known to posterity. It is in this capacity tbat he has conferred on society hlessings which are rapidly extending to the widest limits of civilization, and which already cover Europe and one half of America. The introduction of railways is the great distinguishing event of the thirty years' peace, and to them must principally he attributed the strong honds of amity which are continually drawing nations closer and closer together. It is to railways, and the unity of international interests arising from them, that we are indebted for the maintenance of that peace, unbroken for thirty years, and for the very remarkable events we are now witnessing in the existence of a *casus belli* in the heart of Europe, and yet of the invincible reluctance of the great powers to supply the fuel for a general war. Tbe peace of Europe will now, we may trust, by the progress of railways, and the consequent multiplication of intercourse, be rendered as suhstantial as the peace of the nations of the heptarchy of England;—for we bave nearly reached that part of railway intercourse,

* Institution of Mechanical Engineers.

when the capitals of different nations of Europe are not separated so far from one another, either in the length of time, or in the rarity and peril of intercourse, as were the five capitals of the Anglo-Saxon kingdoms of our ancestors: Canterbury, York, and Gloucester, were then more distant than are now London, Berlin, and Vienna.

How all this was early brought about, how much George Stephenson had to do with it, is now too familiar to every mind to need repetition. You all know how he early got permission from Lord Ravensworth and the proprietors of Killingworth collieries to make an iron substitute for the horses which drew his coal waggons; how he succeeded in driving teams of waggons some six miles an hour; but all of you who recollect the huge unwieldy-looking monsters of that early time, and especially those who, like myself, then had to do with them, must remember how little we dreamed of seeing these clumsy affairs go 10 or 20, much less 50 or 60, miles an hour. Indeed, whether we look at the railway or the machine, both would have been smashed to pieces had any force accelerated their speed to 10 miles an hour. It was never dreamed of, except by one dreamer, who believed in 10, 20, 50, and 100 miles an hour, and who had recently determined to reach it.

The two inventions which have been combined to produce the modern railway system, may be said to be the malleable iron rails and the locomotive engine. These were the two elements of high velocity—each of which formed the absolute condition of the existence of the other. Without the system of laying a continuous wrought-iron rail, the notion of a velocity of 50 miles an hour could not have been entertained; and without the locomotive engine, such an expensive line could never have proved remunerative. Most of us can remember when the idea of laying wrought-iron bars of 50, 70, or 90 lbs. weight per yard, for continuous miles, was an expense so utterly beyond the conception of the time, as not to be entertained for a moment; and this for an obvious reason, that no particular amount of traffic would have paid for it. I think I am warranted in saying, that no amount of traffic which horses, merely, could convey along a line of modern railway could yield a remunerative return, unless, perhaps, under peculiar circumstances, which are exceptional; I am therefore, I think, safe in saying, that the wrought-iron railroad was essentially dependent on the locomotive engine. But that the modern locomotive engine could not subsist without the wrought-iron rail, and its multifarious appendages of chains, keys, locks, sleepers, switches, crossings, sidings, and turntables, is too evident to need proof. Without the smoothness of the rail, the engine would be jolted to pieces, and without the easy motion which it gives, the engine could not be made to draw a sufficiently profitable load to pay; and, further, unless made of wrought-iron, it would be impossible to attain the high speed of the locomotive without imminent danger. It therefore appears that the continuous wrought-iron railway and the locomotive engine were inventions intimately related to each other, and each a condition of the other's success. To Stephenson we are indebted for the chief features of improvement in both. It was the joint perfection of the road and the engine which created the Liverpool and Manchester line, and all the progeny of that wonderful and gigantic experiment—an experiment whose complete success now bears incontrovertible testimony to the genius of the man.

There are several lessons which the life of Stephenson should enforce upon us, the members of a profession which he advanced, and of a society which he so materially assisted in founding, and in the promotion of which he took a constant and deep interest. Indeed, we cannot cast even a hasty glance back over the events of his life, without perceiving that the foundation of our society was an act most appropriate to the termination of a career so arduous and successful. Let us endeavour to define some of those objects, and then consider how we can best accomplish them.

In the first place, then, one of the great objects of our society is the encouragement of mechanical invention, and the promotion of scientific improvement. Thus it becomes our duty to supply to this generation a great want, chiefly felt by Stephenson in his early career. The unhappy moments of his youth were those in which his inventions encountered the opposition of prejudice and interest, and when his propositions were decried, because of their very originality,—because they were new, strange, unheard of, and therefore contrary to verified opinion. What he wanted and could not find in his youth, this society presents to the youthful genius of this generation,—an enlightened, unprejudiced, and first ordeal, where every youthful inventor, every mechanic of original talent, every proposer of that which is new and promises to be useful, will find a body of experienced practical men, to whom the country looks up as her wisest sons, ready and willing to listen to the plans, to test the proposals, to weigh the value, and to award the praise and approbation to which the rising Stephensons of this generation may aspire; but which the old Stephenson could no where find, and in the want of which he was compelled to expend many years of vigour and energy in obscurity and penury. Let us see that in our hands no youthful genius, however little known, shall find his genius obscured, or his energies discouraged, eclipsed, or extinguished. If I rightly interpret the feelings of this society, they would hail with welcome any discovery, and co-operate heartily and disinterestedly in giving to the world its benefit, and to genius its honours and rewards.

Another circumstance must have greatly impaired the means of usefulness of Stephenson in his early life, and one that he most deeply felt, —viz. the want of knowing that which other men were doing, and had done before him, in subjects allied to those in which he was occupying his mind. Thus much we know with certainty, that no man was more happy to communicate, in after-life, to others the abundant stores of practical knowledge he had accumulated, and that no one felt a more kindly interest in the inventions and plans of younger men, or was more disposed to promote their interest and forward their views. Let us regard it as a part of his legacy so to impart, liberally, to all younger members of the profession, what more knowledge or greater experience may have enabled us to acquire. After all, there is no tribute more gratifying to the members of our profession, than the due appreciation by each other of that which each of us may have done to advance the interests, and increase the resources, of mechanical science.

It would not be fair to the character of our late president to omit from our recollection the very large and original views which he entertained on general science. It has been too common in our profession to place science and practice in opposition to one another, as if true science and hard practice could possibly be opposed. If science means that which is carefully ascertained, and accurately defined, and truly demonstrated, —then it is impossible that any sound practice can possibly stand in opposition to, or independent of, it. If practice means the knowledge which is founded on the actual facts and experience of intelligent men, it is impossible to see how the largest amount of that knowledge possessed by any one man, can differ from the extensive and generalised facts in which science embodies the experience of all mankind. Stephenson is an example of a remarkable freedom from this prejudice. He was eminently a practical man. He wrought early, and much, with his own hands. He had wrestled with matter, and knew all its qualities by feeling it, and pushing it, and pulling it—by cutting, and filing, and chipping it. He had hammered it hot and hammered it cold—he had melted it and moulded it, planed it and sawn it, broke it across, pulled it asunder, and twisted it round. He knew its action and its reaction, its inertia and its momentum, its *vis mortua*, and its *vis una*. His was a supremely practical and personal acquaintance with the laws, and property, and phenomena, natural to matter, whether solid or liquid, fluid or gaseous, mineral or aerial, more than any man who has ever risen to eminence. Stephenson was entitled to rank as a consummately practical man. But was he not equally, or more, a scientific than a practical engineer? Was there ever a bolder theorist than he was? Were there ever more daring scientific speculations than those wild flights in which his genius delighted to break forth? On chemistry, vegetable physiology, vital mechanism, electricity, galvanism, the theories of gases, on the inert constitution of matter and of heat, and even on the mechanism of the mind itself, he had deeply thought, profoundly read, and boldly and fearlessly speculated. Every step in his life was the realisation of what had before been a theory. It is true he was not educated early in the rudiments of science, at school or at college; but what of that? what is life but a great school? Is not the press our school, and necessity our school of invention? Stephenson read and studied science;—he was not ignorant, but he was self-taught. Before he became a great man he had studied profoundly; and he does not appear to have ventured on any construction or invention, before having accurately, and generally truly, calculated, by the principles of science, its probable and actual results. In all his works, Stephenson exhibits to us embodiments, eminently practical, of the profoundest principles of mechanical science. Let the men among us who desire to emulate him most, endeavour to combine, in the greatest degree, the truest science with the soundest practical sense. These are not times in which any of us can afford to dispense with any science, or any practice, that it may be in his power to obtain.

I will now venture upon an illustration of the advantage of uniting high science with extensive practice, which has often occurred to me as an excellent illustration of Mr. Stephenson's scientific knowledge, and also as an illustration of the advantage he would have derived, as a practical man, from having been still more profoundly scientific than he was. Stephenson, we know, invented the fish-bellied rail, and a great invention it was thought in its day. The Liverpool and Manchester railway was opened with it. It was an invention to give, with a small addition of metal to the under middle side of the rail, nearly double the strength; and this it successfully accomplished. But here he stopped short: he had

not science enough to see, that by making the wrought-iron bar in long lengths, stretching over a number of blocks, or sleepers, he had brought it into a new condition, to which a much higher rule was applicable;—he neglected the difference between a rail having a joint at every chair, and one having only a joint at every fifth or sixth chair; had he perceived that, he would have invented the parallel rail, and would have learned that the joint chairs require to be nearer together than those removed from the joint by a fixed proportion. The fish-bellied rail was a failure. It was the result of science; but of science of which there was not enough. It was also the result of practice; but of practice under different conditions. It was reserved for Mr. Buck, a profoundly scientific pupil of Stephenson's, to develop the true science of the wrought-iron rail. Where not a little science had failed, a little more made the invention perfect. Let us learn from this to be always trying to obtain a little more science, as well as a little more practice, than we have got,—remembering that Stephenson continued his education of himself to his dying day.

The best testimony, however, which Mr. Stephenson has borne to the value of scientific education to a practical man, is to be found in the course he adopted for the training of his son to our profession. The assiduity with which he laboured at clock-making, the cleaning of watches, or any other industry, in the intervals of his regular business, in order that he might be able to afford to him those blessings of education of which he himself so deeply felt the want, is one of the most charming features in his character. His most earnest desire, in early difficulty, was to give Robert all those precious thoughts and truths which he himself only acquired late and too laboriously. And how admirably his plan succeeded, his son's unclouded success, both as a mechanical and a civil engineer, are the evidence to us, as indeed they were the subject of just pride to himself, who never spoke of his son without strong emotions of joy and pride. There are none of us who will question either the justice of his pride, or the soundness of his plan of education.

It is one of the peculiarities of genius to inspire those within its influence with some of its own fire. This was peculiarly the case with Stephenson. Nearly all the present ornaments of our profession have been his pupils. He was the founder of a school of eminent engineers, who in England, Europe, and India, are now extending, amongst all portions of the human race, the blessings of those great bonds of civilization and social intercourse which he first fabricated. It is to his labours, and theirs, that this country owes the addition of £200,000,000 to its productive wealth, the opening up of a host of new branches of industry, the quickening and invigorating influence of rapid and cheap intercourse; and to him that the poor everywhere owe the blessings of cheapened coal, and the facilities of social enjoyment and healthful recreation.

In this brief notice of the chief features and character of our late president, which I have thus imperfectly, although most earnestly, sketched amid the bustle of business, I have dwelt mainly upon such features and characteristics as were peculiarly interesting or instructive to us, as members of an institution founded, in a great measure by himself, for professional purposes. I have regarded, therefore, chiefly his professional character; but I cannot conclude without expressing an earnest wish, that his life as a man, exhibiting the beauty and excellence of his character in all its cheering aspects, as a boy, as a workman, as an engineman, as a viewer, as an engine-builder, as an improver of mineral railways, as the engineer of the Liverpool and Manchester railway, should be written by some one who has leisure to collect, from his many friends, all their recollections of him, while they remain fresh and accessible. I should desire also to see a detailed account given of his progress, his difficulties, and his means of success in any one of his labours. This would be a most valuable and instructive work; and I do not know on whom it should devolve more properly, to see such a work executed faithfully and judiciously, than on this society, whom he made the favoured recipients of his knowledge and experience, and who ought to consider themselves as his literary and scientific executors, to whom the world may naturally look to see justice done to the memory of one of England's greatest men, the founder of our railway system, and of the Institution of Mechanical Engineers.

IRON MARKET-HOUSE AT SAN FERNANDO, TRINIDAD.

Illustrated by Plate 21.

The simple discovery of the enormous stiffening power gained by rolling or stamping flat-iron plates into a curvilinear or angular section, termed "corrugation," has added largely to the already innumerable uses of this metal. The building arts have mainly profited by the modification, which beautifully adapts it for side walls and all classes of roofing. In our distant colonies, more particularly in the West Indies, where ordinary brick and stone erections are for many reasons inapplicable, the corrugated sheets have presented a material extremely well suited as a substitute, and we find they are being extensively adopted in those localities which are easily approachable by shipping. The latest example of the kind is a market-house, now erecting by Mr. J. H. Porter of Southwark, London, for the town council of San Fernando, in the island of Trinidad. Mr. Porter has for some years bestowed great attention upon the construction of iron buildings for various purposes, and he has recently still further availed himself of the advantages of the system of corrugation, by constructing girders and pillars, and all the main supports of this material.

Plate 21 contains a longitudinal elevation, and a half plan of the building; it is in reality longer than we have shown it, by one panel at each end—the second panel from each end having been removed to accommodate it to our space. Its length is 80 feet; width 30 feet; height from sill to wall-plate, 14 feet. The main stanchions are formed as pilasters, with pedestal bases, and are of cast-iron, secured by bolts to a strong foundation. They of the ⊥ section, the space between the back and front flanges, being filled by the panels of standing jalousie work, or louvring, which are bolted into them as in a frame. These panels are of galvanized plate-iron, riveted up with strong galvanized hoop-iron at the front and back, the sides, and in the centre, the hoop-iron of the sides being concealed by the face of the pilaster.

The lower panelling is of galvanized corrugated iron, in a top and bottom frame of wrought angle-iron, bolted to the pedestal bases. A space of an inch is left below these panels (which will have blocking pieces of stone between the pilasters), in order that the floor of the building may be thoroughly cleansed with water.

The open trellis-work connecting the upper ends of the pilasters is of wrought-iron, with top and bottom flanges, each formed of two bars of angle-iron, with the flat trellis bars rivcted between them. The roof is composed of wrought-iron principals, one upon each pair of pilasters. The rafters, struts, and purlins are of angle-iron; the tie-rods and king-bolts of round-iron.

The covering of the roof, as well as that of the gable ends, above the trellis-work, is entirely of galvanized corrugated iron. Access is obtained to the building at each end, by a pair of wrought-iron gates, 9 feet 9 inches high, and 7 feet wide. The total weight of the building is about 22 tons, and its cost, delivered in the docks in London, £550. Freight and erection, not including foundations, about £100 additional, making the total cost about £650.

In many of the colonies, building materials have to be imported at a great expense, and the high price of skilled labour acts as a powerful preventive to the substantial construction of the average buildings of the country. Hurricanes and earthquakes have too often shown the necessity of great firmness and substantiality, and the corrugated iron certainly possesses a greater claim to a general application, than flimsy brick erections. Up to a late period, the too frequent use of iron in tropical climates has been effectually checked by the corrosive effects of the climate; but the system of galvanizing has remedied this evil, and iron, when protected with a zinc covering in this fashion, is proof to the atmospheric influence. Originally, iron dwelling-houses were objected to on the ground of their greater tendency to heat, but, practically, the metal has some advantages on this very head. The double metallic walls oppose a thick non-conducting stratum of air to the action of the sun's rays, and this air, when at all heated, invariably gets into motion, and plays an important part in the ventilation of the building.

Next month we shall furnish a transverse sectional elevation of the building, with some of the chief details.

LIME.

Lime may be called, with great propriety, nature's first great chemical re-agent: its properties adapt it to an almost infinite variety of purposes, and its universal distribution is a significant indication of its importance. In a previous article,* we noticed the importance of "Sand," and it is hardly possible to overrate the value of its services; but whilst most of the properties of sand are of the negative or passive character, lime possesses positive and active powers of the greatest chemical energy. The importance of many of the functions exercised by lime, in reference to the human body, would, of themselves, render its consideration peculiarly interesting. For example, the various muscular actions are indebted for their effective application to the assistance of the framework and levers of the skeleton, the bones of which it is composed owing their strength and solidity to the salts of lime which they contain. As a series of mechanical agents, bones form a most important part of the bodies of animals; and in the skull, as a defensive armour to the brain,

* Curiosities of the Application of Sand, p. 12.

lime again has a claim upon our respect, as a guardian of the most valuable of our treasures. Amongst the lower class of animals, the Zoophytes and Crustacea, lime is perhaps still more necessary for the protection of their tender bodies. In the formation of coral islands, we have a remarkable example of the application of lime to one of the most singular of nature's operations, the growth of dry land in the sea. Another wonderful instance of the natural use of lime is found in some of the limestones, which are evidently entirely composed of the shelly armour of lime, of myriads upon myriads of insects, whose tombs are now hard rocks and mountains. Some of the sandy or siliceous rocks are also composed of the sandy coats of insects; as, for instance, Bohemian tripoli, which, as M. Ehrenberg has shown, consists of innumerable quantities of microscopic shells. The geological distribution of lime over the surface of the globe appears to he, at least, as universal as the presence of animal life; for, as all animals contain lime in their structure, it must be a constituent of the vegetables forming the basis of their food, and of course the plants must obtain their supply from the soil or medium in which they are fixed. It is accordingly found everywhere: the waters of the ocean contain it in considerable amount; every twenty-five pounds of common salt, being associated with one pound of salt of lime, and it is thus conveyed over every portion of the globe traversed by the sea. In the land, as in the sea, it forms an equally eminent constituent: the limestone group of rocks, the chalk cliffs of our coasts, and the mountain limestones of the interior, are memorable instances of the vastness of its storehouses. But it is not confined to these immense receptacles alone; it is present in most, if not in every one, of the various strata of rocks. In all alluvial deposits it forms a part, or an entirely barren waste denotes its absence; and from the "father of rocks," granite, through all the series in geology, lime is present in a greater or less degree, varying, from almost perfect purity in the limestones, to mere traces in some of the aluminous and siliceous kinds.

The presence of lime is as necessary for the existence and growth of plants, as it is for the sustenance of animals; and in the well-known instance of clover, we see how greatly the influence of lime assists the full development of the plant. Many seeds, those of clover among the number, lie dormant in the ground for ages, of whose duration we have no idea; under suitable circumstances, the long-buried germs spring forth to life. In some soils, each deeper ploughing brings up some of these hidden seeds to the influence of the climate, and a magnificent crop of weeds, from, possibly, antediluvian seeds, is the first result. On other soils the same cause, combined with the favourable circumstance of a manuring deposit of sulphate of lime (gypsum), produces a spontaneous crop of clover.

One other instance of the utility of lime in the animal kingdom, and we will proceed to consider a few of its many applications to the arts of life. We refer to the protection afforded to the embryo by the shell of the egg; the shell may be said to consist of a vault of stones of lime, cemented by a network of fibrine.

In these instances, the lime, *in situ*, plays only a negative part: it is a dead mass of matter, affording shelter or support by its powers of resistance; and it might therefore be concluded, that any other inert body, having the requisite solidity and strength, would answer the purpose equally as well. That such is not the fact, is mainly owing to the peculiar chemical properties of lime, by reason of which it is dissolved with facility in various liquids present in certain parts of the body; and when thus conveyed by the circulating current, to the spot requiring its assistance, by a natural change in the menstruum, the lime is deposited in full possession of all its admirable properties, having undergone transformations of which, under similar circumstances, no other known body is capable.

In the arts, lime, as the chemical constituent of "mortar," holds a well-known place in the list of cements. It may be said that the natural state of lime is a carbonate, or rather, that lime in its ordinary natural state is always combined with another substance, as with carbonic acid in the carbonate (limestone, chalk), sulphuric acid in the sulphate (gypsum, alabaster, plaster stone, &c.), and with phosphoric acid in the phosphates (coprolitic and bone earths).

With many substances, carbonate of lime acts only as an inert body (the sulphates and phosphates of lime being still more remarkable for their inaction), but, under suitable circumstances, the carbonic acid is readily removed, and the pure lime thus left is easily acted upon in various ways, and then as readily combines with fresh carbonic acid from the atmosphere, and regains its original inert character.

Limestone is a carbonate of lime, and the carbonic acid is driven off by heating it in a current of air; free access of air is essential to the success of the operation, as the limestone would melt at a high temperature, without losing its carbonic acid, if air were excluded. The loss of weight in burning, varies from 20 to 40 per cent., according to the purity of the stone. The "shell" or "quick" lime thus produced, is "slaked," by the addition of water, for which it has so strong a chemical affinity, that the combination takes place with remarkable avidity, and considerable evolution of heat. The water thus chemically united with the lime, is in the proportion of 9 parts of the former to 28 of the latter substance, and the powder is then quite dry. Any additional quantity of water rather tends to diminish than to increase the heat of "slaking;" this phenomenon being one of the series subject to Guy Lussac's law, that heat is extricated when water combines chemically with bodies to form hydrates, but mere mixtures or mechanical solutions are always attended by a lowering of the temperature. The extra quantity of water is absorbed by the lime, in the same manner that it is absorbed by sand or charcoal, *i. e.* mechanically; but an excess is always added for the sake of rendering the mass plastic, as it is in this state that it is used as mortar. Sand is added to mortar to strengthen the compound, and also to turn the chemical affinities of the lime to greater account; these two substances possessing a strong mutual attraction, and, by combining together in a small degree, add to the consistence of the cement, at the same time that it is economically increased by the addition of a cheap material.

By the absorption of carbonic acid the lime "sets" and hardens. When the mortar is very moist, or, on the other hand, when very dry, this action is very much retarded. The presence of a little extra water seems necessary, and, in the ordinary process of building, the bricks absorb the surplus water from the mortar, and leave it in a suitable state for assimilating the carbonic acid. The exact state is more nearly attained artificially, by mixing the dry hydrate of lime with an equal weight of crystals of sulphate of soda in powder. In a layer of this mixture only an inch thick, the absorption is so rapid as entirely to prevent the passage of carbonic acid; the energy of the chemical action frequently raising the temperature of the materials above the boiling point of water. This mixture has been proposed for removing the carbonic acid from badly-ventilated rooms, the diving-bell, &c., and is frequently used in the coal mining districts, where repairs are necessary in mines or pits containing "choke damp" (carbonic acid). The men breathe through the compound contained between two coarse canvas cloths, and are thus able to work in an atmosphere which would be often highly dangerous, if not fatal, to human life. The occasion which generally leads to the adoption of these measures is, when the pumping machinery has been injured by an explosion, and the mine, in consequence, has been partly filled with water, thus completely checking the ventilation, leaving the choke damp in the pit. By the contrivance we have mentioned, repairs are effected which would otherwise be abandoned as impossible.

Mrs. Marshall Hall (lately residing in Manchester), by taking advantage of some peculiarities of certain organic bodies, in conjunction with quicklime, has been able to form and absorb carbonic acid so rapidly, that a mixture of lime, and suitable organic materials, is converted into a mass like marble, in an almost inconceivably short period of time. This has thrown considerable light on the formation of the limestones round the vegetable fossils, the carbonaceous parts of these plants being frequently found in their original forms. Lime and blood, or some other animal substances, as cheese, glue, &c., have formed favourite cements with coppersmiths and others, from time immemorial. Whilst pointing out the advantages of lime to the mechanical community, we ought, in fairness, to mention its drawbacks: if we name "boiler scale," which is composed for the most part of various salts of lime, most practical men will admit, that sometimes, at least, lime is a nuisance. Hard water (*i.e.* water containing lime) is another annoyance to that very necessary *industrieuse*, the washerwoman. All the marbles are carbonates of lime, and we must, per force, think highly of the material in which so many of our noble works of art have been embodied. The decorations of our handsomest apartments, in the shape of mantel-pieces, pillars, floors, table tops, &c., are in general constructed of various kinds of marble, or, where the real substance cannot be obtained, we see how frequently the house artist essays an imitation. Perhaps we should regard "the oriental pearl," and its handsome relative and neighbour, the shell that once contained it, "mother-o'-pearl," as the most costly instances of carbonate of lime in the class of ornament; but they who prefer the useful to the merely ornamental, will doubtless give the preference to marble, even if the strict utilitarian dismisses it, to the formation of his bath, or for the shelves of his dairy.

It is particularly interesting to notice the use made of lime in the chemical manufactures; richly does it deserve, in this respect, the title of "the universal re-agent." We can point out only the most noted examples, for to enumerate every instance of its application, would require ample leisure, and would fill a bulky volume; but if our readers will watch the manufactures of this kind, they will find lime busily engaged in a multitude of operations where, very likely, they least expected to find it.

Iron has been aptly named "the bones of the giant civilization." In our previous article on "sand," we noticed the necessity of a flux of sand and lime, for the successful smelting of iron ores; thus we see that lime lends its aid in forming the good giant, who is, we trust, to drive all the gohlins from among mankind.

It has been said that a nation's progress in civilization may be measured by its consumption of soap (a remark, by the way, for our excisemen to digest), and if this proposition be regarded as something near the truth, we may say that the consumption of lime is a truer indication, for lime is not only a most active agent in the soap manufacture, but in a multitude of other trades as well. Soap is a compound of an alkali and an oil or grease. Soda and potash are the alkalies employed; they are always produced in a carbonated state (*i. e.* combined with carbonic acid), and before they can enter into combination with the oils, they require to have the carbonic acid removed. This is effected by boiling a solution of the alkali, or a "lye," with quicklime; the carbonic acid then unites with the lime, and leaves the alkali free, or "caustic." Potash, which enters into the composition of the soft soaps, is generally procured from wood ashes; but this alkali is used in much smaller quantities than soda, which is the active ingredient in hard soaps, and is much indebted to lime in its manufacture. The great source of soda is sea-salt (chloride of sodium, sometimes, although improperly, termed muriate of soda); by the addition of sulphuric acid, this is converted into sulphate of soda, or "salt cake," muriatic acid being volatilized. The "salt cake" being roasted with coal dust and limestone, a very complicated series of reactions take place, and the product, "black ash," being lixiviated with water, carbonate of soda is dissolved, and a residuum is left, which is a compound of lime and sulphur; the latter substance being the peculiar constituent of sulphuric acid.

Coal-gas may be esteemed another mark of civilization, and there are few persons who are not aware that, after its formation in the retorts, it requires much purification before it is fit for being burnt to advantage. Lime performs the principal, if not the only part of this necessary cleansing; by being passed over quicklime, or through a mixture of lime and water, carbonic acid and various sulphuric compounds are absorbed, and the gas is left comparatively pure. In the now necessary art of dyeing, lime is essentially serviceable. By the agency of copperas (protosulphate of iron) and lime, indigo is reduced to a state peculiarly well adapted for penetrating the various tissues. Lime also assists in the production of various colours, and in "bleaching powder" as the absorbent of chlorine. It is not of service to the dyer only, but white fabrics of all descriptions, from the most costly lace to the coarsest cloth, as well as all the various kinds of paper, are much indebted for their beauty to the go-between services of lime in carrying chlorine for their improvement.

In the tanner's yard, lime enters upon another department. The hair is removed from hides by immersing them for a short time in a mixture of lime and water. In the extraction and purification of organic acids, such as the acetic, citric, tartaric, &c.; in the refining of sugar; in the separation of iron and other metallic oxides from solutions of neutral salts; in short, in chemical operations too numerous even for us to mention, lime plays all the parts of a universal re-agent. Agriculture, the most ancient of all arts, lies under many and great obligations to lime. We have already remarked the necessity of the presence of lime for the growth of plants, and therefore, in some cases, its mere addition is beneficial; but the properties that render it more generally valuable to the farmer, are the chemical actions which it gradually exercises upon the soil. Plants require the nourishment of many mineral substances, of which soils (especially clays) contain considerable quantities, though they are locked up beyond the assimilating powers of the plants by the chemical force of their combinations. Upon the addition of lime new affinities are called forth, and the substances which the plants require are gradually liberated in abundance. In this instance, dolomitic limestone (a peculiar kind containing magnesia joined with lime) exerts the greatest energy. Another important application of lime is in reclaiming waste lands. In the case of bogs, perhaps no known fact in husbandry admits of clearer proof of its value. The water-draining from peaty or bog soils is found to be darkly coloured by a substance known as "humic acid." The solution exerts great contractile powers upon the pores of vegetable and animal tissues, by virtue of which it filters very slowly through paper, and is highly injurious to most plants. The water is always darker after rain, because it then contains a small quantity of ammonia, this substance dissolving an extraordinary amount of humic acid. For this reason, rich manures, which contain large quantities of ammonia, upon these soils, do harm instead of good. When lime is added to the solution, humic acid falls with remarkable rapidity in brown insoluble flocks, the supernatant fluid being clear and colourless, and no longer prejudicial to plants. A good dressing of lime, in conjunction with drainage, is therefore the first step in reclaiming land of this character, and lime as pure as possible, particularly that without magnesia, is the best adapted for the purpose.

We have hitherto considered only the applications of lime in its natural state of a carbonate, or as quicklime; but another natural compound, the sulphate-plaster of Paris stone, gypsum, alabaster, selenite—is also of frequent use in the arts. The finer varieties are carved into various articles, as vases, statuettes, &c., for internal decorations; the beautiful Italian chimney and drawing-room ornaments are formed of this substance, which is so soft as to be easily cut, and yet takes a high polish, but requires to be protected from the weather. In some localities, highly crystallized varieties occur, which are sufficiently transparent to be serviceable as windows, when glass cannot be obtained. The general use of sulphate of lime is in its burnt state, as plaster of Paris; the stone for this purpose is heated nearly to redness to drive off the water, and is afterwards ground; as a cement, and as the ready means of reproducing the most laborious and noble works of sculpture, it is too well known to need much comment. It is also much employed in the manufactures of glass; many of the moulds in which table glass is blown or pressed, are first made in plaster of Paris, and thus form the patterns from which the metal moulds are cast. In the plate-glass manufacture, it cements to the framework of the machinery the sheets of glass which are undergoing the process of grinding and polishing. The history of a square of plate-glass in a window, is a curious instance of the use of lime. The peculiar ductility of the glass at high temperatures, which allows of its being so easily wrought into sheets, is mainly owing to the presence of lime in its composition. During the completion of the process, (*i.e.* in the grinding and polishing,) it is held secure by sulphate of lime, and is finally fastened in its place in the window by putty, a mixture of whiting (carbonate of lime) and oil. Flour spar is a natural compound of lime, in which it is associated with the remarkable substance "fluorine." By the action of sulphuric acid on the spar, hydrofluoric acid is disengaged. Exquisite designs may be etched upon glass by employing the acid, which has the property of acting violently upon all siliceous bodies. The success of lithography depends very much upon the quality of the limestone on which the drawing is made. Carbonate of lime, as whiting, is used for putty, and for a polishing powder; as calcspar, the philosopher employs it in investigating the laws of polarized light; it assists in the manufacture of soda water; as whitewash, it cleanses and purifies our buildings; as muriate of lime mixed with clay, it forms a lute, always moist, impervious to gases, and almost as useful to the manufacturing chemist, as caoutchouc is to the analyst. As the source of the Drummond light (lime intensely heated by the oxy-hydrogen blowpipe), it has rendered important service in exteusive surveys; and in the large microscope, it has revealed scenes of "the invisible world"—the microscopic—to thousands at a time; in short, lime is rendered serviceable in nearly every department of the arts. In thus pointing out the value of certain mineral substances, we would not wish to forget the importance of many others of the same kind—all parts of the universe work together to one common end. We have endeavoured in these papers to trace the part played by two of nature's active agents, and we will return to the subject at a future opportunity, for there are many substances apparently of little importance, but whose properties and services are as important as their investigation is interesting. D.

IMPROVEMENTS IN HYDRAULIC MACHINERY.

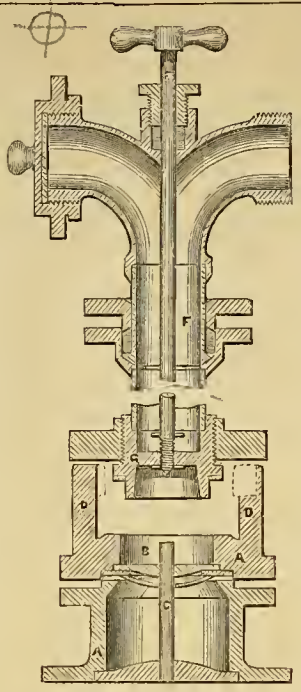
CHRIMES' FIRE-COCK—KIRKWOOD'S PISTON-COCK.

We last month drew attention to Mr. Scott's new hydrant, as one of the signs of the tide of improvement in hydraulic apparatus; and the two arrangements, whose names stand at the head of this article, furnish further confirmation of that opinion. The first-named invention is by Mr. Chrimes, of the firm of Guest and Chrimes of Rotherham. It is available for all the numerous offices of stop-cocks generally; and from its suitability for high-pressure purposes, it would appear to be peculiarly adapted as a substitute for the ordinary fire-plug. Our cut exhibits a vertical section of a two-inch cock, with its stand-pipe detached, on a scale of $\frac{1}{4}$ the real size. A A, Is the shell or case in two parts, bolted by its bottom flange to the corresponding flange on the main pipe. The bottom face of the upper half of the shell is recessed to receive a ring of India-rubber, forming a face for the valve, as well as a water-tight joint between the two parts of the shell. A brass bridge, B, is attached at the same part, for the reception of the spindle, C, cast upon the loose inverted valve; a similar bridge is placed at the bottom of the shell, and the valve is thus steadily guided by the two, being always pressed up against its face, when out of action, by the force of the water beneath it.

The upper portion of the shell has two inverted L-shaped projections, D D, for the attachment of the stand-pipe, when the cock is to be put in action. The stand-pipe is a copper or iron tube, E, having diverging discharge-pipes at its upper end, one or both of which are fitted with brass screw caps, as represented on the left branch. This pipe is fitted with a revolving stuffing-box joint at E, to permit of the setting of the upper dis-

charge-pipes to any position. The bottom part of the stand-pipe has an exterior screw cut upon it, working in an interior one in a collar, which has projecting pins for passing beneath the L projections, D D, a water-tight junction being effected by a leather washer, resting upon the bottom inner face of the shell.

The opening and closing of the valve is effected by a vertical spindle, F, with a cross-head at top; this rod passes through a stuffing-box at the top of the stand-pipe, and is screwed at its lower extremity to work through the fixed bridge, G. It will be seen, that when the stand-pipe is brought to its bearing, the lower end of the actuating spindle will be just above the spindle of the valve, C, a gradual depression of which is easily effected by turning the former, so as to cause it to descend through its bridge-nut, and act upon the top of the spindle. This admits of the gradual upward passage of the water all round the valve, and no shock is felt in opening or closing. The Board of Ordnance have tested the cock both in Yorkshire and at the Tower, with favourable results.



The piston-cock is the invention of Mr. W. Kirkwood, plumber, of Edinburgh, and relates to a distinct branch of hydraulic mechanism. It is intended to supersede the retaining box and cisterns usually employed in water-closets, as it enables the workman to connect the apparatus with the water-pipe direct, under any pressure of water. Fig 1 is a vertical section of the cock; and fig. 2 is a horizontal section through the piston and regulating stop-cock.

A, is the main shell, bored to received the piston, B, which is here represented in its lowest position, the water-way being open; C, is the entrance branch for the water, which passes over the top of the piston, through the opening, D, and out by the discharge branch, E. The piston, B, slides loose upon the lower end of the piston-rod, F, which is of a triangular section at that part, as seen at fig. 2.

Fig. 2.

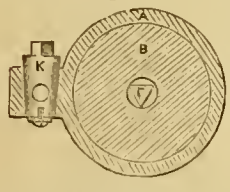
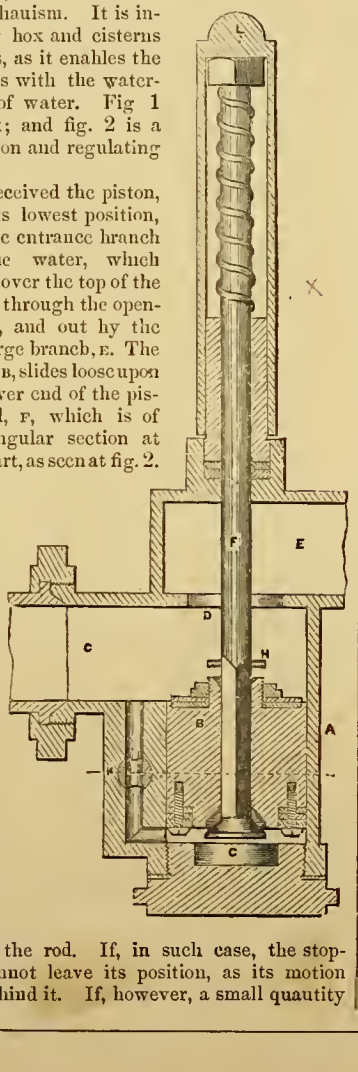


Fig. 1

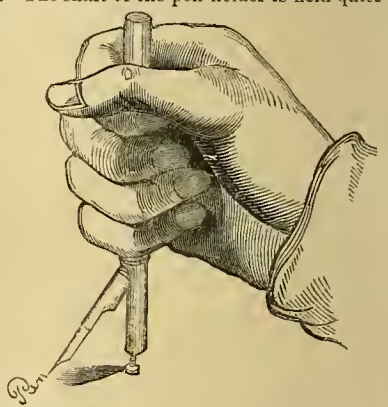


A small conical valve is attached to or formed upon the lower end of the rod, F, a recess being formed at G, to permit of its descent. A small pin is attached to the pistou-rod at H, by which pressure may be communicated to the piston through the rod. At K a small stop-cock is fitted in a branch passage, leading from the entrance-pipe to the space below the piston, which has a ring of leather screwed to its lower face, to render it air-tight below.

In our engraving, the conical valve is supposed to be depressed by some external action upon the top of the tube, L; but if this pressure is removed, the valve will be instantly closed by the action of the spring coiled round the rod. If, in such case, the stop-cock, K, is closed, the piston cannot leave its position, as its motion would tend to form a vacuum behind it. If, however, a small quantity of water is allowed to pass to the bottom of the piston, the latter will begin to rise, but only in proportion to the quantity of water admitted. The upward motion of the piston will then be gradually effected until the leather washer on its upper surface presses against the ground surface of metal round the opening, D, and the full pressure of the supply water, now acting upon the bottom of the piston, through the stop-cock, K, will keep the former tight. When the cock is to be opened by pressure upon the tube, L, the conical valve, K, will open, and permit the water beneath the piston to pass up through it, by the openings left by the triangular portion of the rod; and as this passage is much larger than that through the stop cock, the pressure is thus removed from below the piston, which may now be easily depressed by the pin, H, in the rod. The peculiarity of the arrangement is, that by the simple regulation of the stop-cock, K, any quantity of water may be delivered by it, after the opening power is withdrawn; and when once regulated, it will always continue to deliver the proper quantity before closing.

HOLTZAPFFEL'S PEN FOR ENFEEBLED HANDS.

Parties who, from age, rheumatism, or general physical decay, are unable to hold an ordinary pen in the true position for writing, and have great difficulty in tracing legible characters. The frequency of defects of this class, prompted the late Mr. Charles Holtzapffel to devise the "pen for enfeebled hands," which we have here engraved. The shaft of the pen-holder is held quite vertically, in the central portion of the hand, being grasped by the whole of the fingers; this position can usually be commanded by the most infirm. The lower extremity of the shaft is allowed to rest upon the paper for the support of the hand, whilst the tube that receives the pen or nib, is jointed to the shaft at an angle of about 45°, and is pressed upon the paper by a feeble spring, so as to assimilate in the closest manner to the action of an ordinary quill pen. The holder is adapted to receive a gold, steel, or quill pen. It may be carried in the pocket very conveniently, as it folds up into the size of a pencil-case.



THE MECHANIC'S LIBRARY.

Algebra, Elements of, 12mo, 6s. 6d. cloth. J. Wharton.
Architect's, Builder's, and Contractor's Pocket-Book of Prices, for 1849, 12mo. 6s.
Arithmetic, Questions on, 12mo. 2s. cloth. W. Thrower.
Arithmetic, Answers to Questions on, 12mo. 3s. 6d. cloth. W. Thrower.
Astral Sciences, The Gem of the, 8vo. 10s. 6d. cloth. T. Oxley.
Astronomy, Chambers' Educational Course, 12mo. 10d. cloth.
Bookbinding, Ornamental Art applied to, 4to. 15s. boards. Cundale.
Chemical Analysis, Vol. II., Quantitative, 8vo. 18s. cloth. H. Rose.
Chemical Analysis, Practical Introduction on, by Normandy, 9s. H. Rose.
Chemistry, Elements of Agricultural, 12mo. 6s. J. F. W. Johnstone.
Clerk of Works and Architect's Guide, 5s. cloth. W. D. Haskoll.
Copper Ore Tables, Prefix to, 4to. 5s. cloth. J. Davey.
Drawing-Book for Trees, oblong 4to. 7s. 6d. cloth. G. Barnard.
Engineer's Pocket Book for 1849, foolscap 8vo. 6s. roan tuck. Adcock.
Literary and Scientific Register for 1849, 3s. 6d. roan tuck. Gutch.
Mechanics, Theoretical and Practical, 8vo. 9s. cloth. J. Hann.
Practical Contractor's Pocket Guide, 2d edition, 18mo. 3s. cloth.
School Architecture, crown 8vo. 15s. cloth. H. Barnard.
Science, the Poetry of, 8vo. 12s. cloth. R. Hunt.
Scientific Works, Library of, vol. v. "Weisbach's Mechanics," vol. ii. 18s.
" " " vol. vi. "Quekett's Microscope," 8vo. 21s. cloth.
Shipmasters, Manual for, third edition, 12mo. 5s. cloth. J. Lee.
Steam-Engine, Tredgold on the, new edition, Parts II. III. and IV. 2s. 6d.
Warming, History and Art of, 2 vols. foolscap 8vo. 9s. W. Bernan.

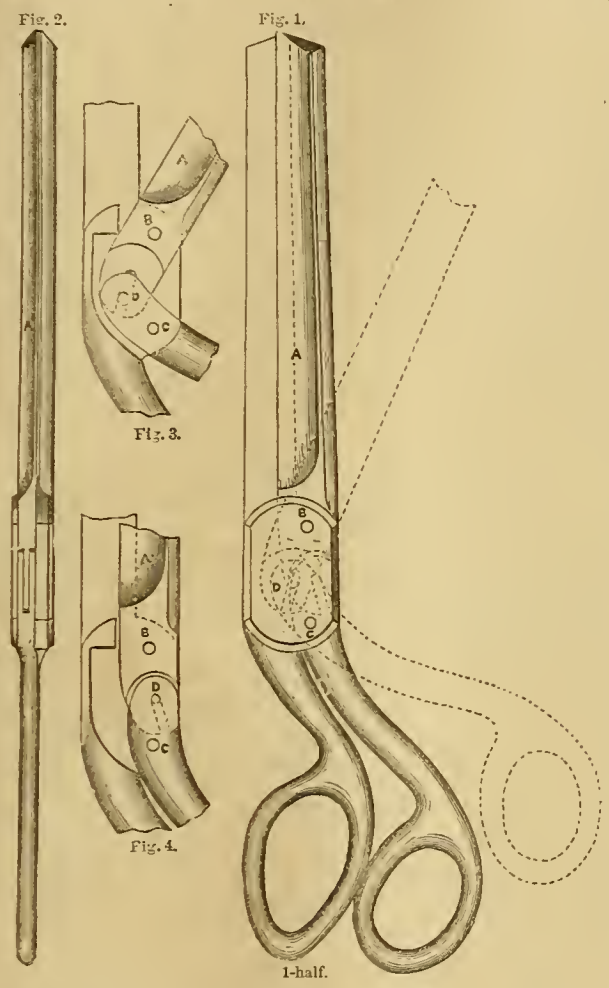
REGISTERED DESIGN.

SILENT SHEARS.

Registered for Mr. Alfred Wilson, 17, *Percival Street, London.*

The peculiarity in these shears consists in the novel joint movement, whereby the lower blade remains stationary in the act of cutting, the

action being performed by the upper blade alone. Fig. 1 is a full side view of the shears, with the blades closed; fig. 2 is a corresponding edge view; fig. 3 is a view of the joint, with the front plate removed, showing the blades open, and fig. 4 shows them closed. The upper blade, A, is detached from its shank or bowl, and moves on a fixed centre at B,



which is carried by the cheek plate, forged in one piece with the lower blade. Its bowl moves on a similar centre at C; its end is forked to receive the slotted single plate end of the blade, A, the slot in the latter being fitted to embrace a pin carried by the slotted end of the bowl, which thus communicates motion to the blade in a very simple manner. When the thumb raises the upper bowl, the blade, A, is also elevated, by the depression of the actuating pin working in its slot, as seen in fig. 3, and in dotted lines in fig. 1. The two centres of the bowl and upper blade are supported between the fixed cheek plate of the lower blade, and the loose front plate, which covers the joint recess, and encloses the whole of the working parts. The joint movement only is registered as new.

REVIEWS OF NEW BOOKS.

RAILWAY LOCOMOTION AND STEAM NAVIGATION; their Principles and Practice. By John Curr, of New South Wales. Woodcuts: pp. 181. London: Williams & Co., 1847.

This book is the production of a vigorous mind, whose owner has studied in both the ancient and modern schools of engineering. Although, in his earlier years, a contemporary of Stephenson, Maudslay, and others, the name of the author has long since disappeared from our catalogue of engineers—he having become a resident in Australia. The facts attending his change of profession may be best gathered from his own detail of some professional squabbles in which he was engaged in 1815. It appears that Simon Wilkin, Esq. of Norwich, supplied him with plans of a steam-engine, drawn by a Mr. Dodd, intended for a vessel then being built to trade between Harwich and Ipswich.

"Besides a multitude of minor defects in the plan, there were two of such magnitude that they were returned to Mr. Wilkin, and a reason given for having done so, which was, that the engineer had not left space for the crank to revolve, so that if it had been so constructed it could not have made one revolution; and second, that the air-pump top, being in part below the cylinder bottom, and within about two inches of it, the air-pump bucket could not be put in its proper place, or extracted when required to be repacked, without the removal of the cylinder. Mr. Wilkin afterwards requested to be furnished with the plan of a proper engine of ten horse-power, and an estimate, according to which a contract was entered into, and the engine put on board the vessel. When complete, the speed of the vessel being only five miles an hour—the power of the engine was doubted,—Mr. W offered a compromise which was rejected, so that he sent to London by advice of counsel for three engineers, whose names were Maudslay, Donkin, and Galloway, in order, as was understood, that he might have sufficient weight of evidence to decide the disputed point.

"The three parties just named continued during six days, in one week, the examination of the principle of the engine, which was entirely new to them, as it would have been to any other parties whose services might have been called into requisition. On the sixth day Mr. Galloway was called to London on business, and the survey was continued by the remaining two, for three days in the following week, when they gave a report that the engine, instead of being of ten horse-power, was only of five. The cause assigned for their decision being, that the engine having two cylinders, the connecting-rods applied to cranks at right angles, and, without the accompaniment of a fly-wheel, had no more power than one cylinder, for it was like two men turning a grindstone, and they had no more power than one! In what school they acquired such notions of mechanics it is not for me to say, but such is the substance of their report, as expressed to myself by the lips of Mr. Donkin. A second compromise was offered and rejected, because, by the aid of a dynamometer borrowed for the occasion of the Earl of Roseberry, the actual power of the engine had been proved to exceed that of ten horse-power in a manner so conclusive, that an apprentice of six months' standing might have known it.

"Mr. Wilkin, acting under the natural impression that the contract had not been fulfilled, caused the vessel to be taken from her moorings in the night, and the engine to be ejected. Mr. Maudslay replaced it by an engine of twelve horse-power, which, when complete, could move the vessel at only one-half the speed of the ejected engine, which, as he had said, was of only five horse-power."

Disgusted by what he deemed unfair play, the author quitted the profession shortly afterwards—a proceeding certainly savouring more of the character of a spoiled child, than of a determined practical engineer, with whom, emphatically, right is might. In thirty-two years we have him again amongst us, and the result of his visit is the book before us.

The readers of the volume will doubtless join with us in an expression of surprise at the positions the author assigns to two professors in the old school of mechanics, Hutton and Emerson; the first is his bane—the last his antidote. Emerson is his god; Hutton his mortal antipathy. Certainly both might rest in peace, for aught that they affect the practical engineering of 1848. With the author's opinions upon "motion, force, and velocity," our readers will have been made acquainted through our own pages; to them we have nothing to add, as they point in a true common-sense direction, and are sufficient to show us the numerous gross erudities and misapprehensions on matters coming every day within the province of the engineer. In his notes on the construction of railways, Mr. Curr proposes wooden rails, with a metallic facing of angle-iron, screwed to the face and inner edge of the rails. An ingenious contrivance is also given for enabling trains to pass curves easily. On each side of the main rail, a timber side-piece is laid, considerably lower than the face of the rail; and immediately over the two inner rails, a pair of small wheels is placed, being set loose on a detached axle. Whenever a curve occurs, the outer of these two rails has an additional strip of metal sufficient to cause the small wheel over it to bear upon it, and thus elevate the driving-wheel on that side, so as to clear the rail and prevent friction and twisting in passing along the curve.

The second portion of the book, which is devoted to the consideration of steam navigation, must wait until next month; our space prevents us now from entering upon it, and moreover, its philosophy is not to be dismissed without a narrow investigation.

CORRESPONDENCE.

ON THE FORMATION OF COAL.

No. III.

If we suppose that wood has been the substance from which minerallized or crystallized coal has been formed, we shall do well to ascertain what substances are found in coal, in addition to those which are found in wood, or, generally, in vegetable substances. These additions must be accounted for from some other source; and we shall help our considerations by ascertaining the action which these substances have upon vegetable matter.

All coal contains iron, more or less; what, then, is the action of iron upon wood—what do we find to be the actual case? In the peat-bogs of Ireland, where ochreous iron waters prevail, we frequently find trees submerged, and surrounded with a watery solution of iron, and the wood is invariably charred; and, what is still more common, we find that if a piece of iron, a nail for instance, has been long inserted in wood, and exposed to moisture, the wood will be considerably charred for some distance round the metal. In the plumbago, or black lead of commerce, we have an instance of the great quantity of charcoal which a small amount of iron has charred, as much as 10 parts of iron being combined with 80 parts of charcoal. Here, then, is a convincing proof of the ability with which iron converts wood or carbonaceous matter into char.

One step, therefore, for the conversion of wood into coal would be gained, if, in the coal formation, we suppose that a solution of iron was presented to the vegetable matter out of which coal was formed; and this, too, would account for the fact, without the presence of heat being required for this part of the operation of conversion.

In some of the sandstones which overlie the coal measures, pieces of wood are frequently found embedded. These are changed into coal or char; but in such sandstone, iron is always one of the articles in the composition. This goes so far to prove the facts before stated.

That iron will effect the purpose of charring wood cannot be doubted, and that iron is present in coal is also certain. But we have another strong point to notice, in proof that iron has some important office in the formation of coal; for the superstratum accompanying coal is generally ironstone; indeed, ironstone itself appears to partake of the nature of coal in a considerable degree, from the immense quantity of carbonaceous matter with which it is combined. Was not, therefore, vegetable matter, the matrix in which the solution of iron being deposited, the cause of the formation of ironstone—that is, in all carboniferous ironstone? There is every proof to warrant that such was the fact, by the researches of the geologist. If so, then coal is formed from vegetable matter with a minimum of iron. Ironstone is a coal formation also, with a maximum of iron; and that each formation originated under the same system is pretty apparent also, for they accompany one another, and are more or less similar in constitution and constituents. If so, then we have the process by which the woody matter of coal has been formed; and it is exemplified before us in every peat-bog, which is the first step in the coal formation.*

Fine clay forms the bed or substratum of coal, without exception; the stigmaria ficoides are next found, then the ferns and aquisitaceæ, afterwards the sigillaria, pines, then coal.

Under every seam of coal, without exception, there exists a bed of clay filled with the remains of the stigmaria, and of this plant alone; and, further, the plant is found in no other stratum in the coal measures but in that immediately underlying the coal.

Finally, on this point, we can form ironstone synthetically, by subjecting wood and iron filings to a high degree of heat, in a crucible closely luted up. The result is according to the proportion of iron used; by the addition of more or less of the filings we form plumbago, or a purely carboniferous ironstone. The more frequently the operation is repeated, to a certain degree do we find the perfection of the result; and for the presence of other matters in the common ironstone, no great stretch of ingenuity in the operator will enable him to combine them also. Not that I would infer that ironstone has been thus formed in a natural state; there are evidently other modes by which nature could accomplish this, on which we may perhaps hereafter treat. Similar results may be accomplished by such means as are compatible with the nature of the substances discovered in the minerals themselves, aided by the laws of nature which surround them, or which have been in action at the time of the formation.

The main question, that iron will carbonize wood, I think, is satisfactorily proved; if so, we have realized a fact in the formation of coal.

G. R. B.

Glasgow, November, 1848.

EMPLOYMENT OF BELLS FOR RAILWAY SIGNALLING.

Suffer, I pray you, this short article, upon Bell Signals, to appear in your excellent journal. Did I not deem the subject an important one, I would not presume to offer any remarks. The purport of this communication is to direct the attention of railway managers to the subject, with a view of inducing them to furnish the guards of trains with hand-bells, with which to signal the driver to stop when anything has gone wrong, of which he is not cognizant. Although so many accidents have happened from a want of efficient signals, yet such is the unconcern and blindness of the officials, that now, in England, guards are without signals. Although many complex absurdities of clumsy schemers have been tried, and in their turn rejected, yet, strange to say, managers will not sanction the trial of hand-bells. Even the great railway engineer, the deceased George Stephenson, has recommended that two guards be placed, one at either end of the train, to stare at one another! and Mr. M'Connell has recommended the use of a galvanic battery, and an electric telegraph-bell, upon the tops of the carriages for their use! Now, what is the use of such contrivances, and where is the necessity? Instead of placing a guard upon the tender, with his back to the engine, and making a fool of the man, give the hindmost guard a good hand-bell, which, in time of danger, he can ring, and so easily, and almost without exertion, signal the guard to stop. What can be more simple and efficient than this? The bell is not liable to become dumb, nor the driver to become deaf, so that there is no chance of the sound not being heard or the apparatus becoming useless. One guard, with a bell, will be as useful as twenty with any established code of complex signals. Bells are used at all the stations for signalling the arrival and departure of trains: what objection then can be urged against their employment upon the trains in motion? I assert, with confidence, that no other plan or apparatus, hitherto proposed, possesses equal efficiency or simplicity. G. Stephenson has said, that "all contrivances on railways ought to possess simplicity;" and then, himself, virtually contradicts such assertion, by recommending a complicated apparatus; for, at a meeting of the Institution of Mechanical Engineers at Birmingham, he sanctioned the absurd plan noticed above. I am not the original proposer of bell signals, as I see 'H.' has recommended them in your journal long ago; but, so impressed am I with the value of the proposal, that I could not abstain from addressing you.

Will any of your readers favour me with the practical objections against this plan? I shall feel obliged by learning them, as I have never heard of them yet.

To sum up, my recommendation is, simply, that each guard be provided with a large hand-bell, for the purpose of signalling the driver to stop the train when there is danger that he has not perceived.

Birmingham, Nov. 17, 1848. TINTINNABULUM.

[With reference to this proposition, we may refer our readers to page 68, *ante*.—ED. P. M. J.]

THERMOMETRIC OBSERVATIONS.

A correspondent of the Practical Mechanic's Journal, under the signature of "H. R.," finds a difficulty in determining the degree of temperature at which melting wax becomes solid, and inquires of the mathematical friends of that journal, for an exact rule, by which, knowing the temperature of the room, and the position of the bulb (of the thermometer) upon the scale, he may be able to determine the true melting point, from the observed or apparent one.

His experiments have produced different results, which he assumes to have arisen from the circumstance, that the bulb of the thermometer only was immersed, and from the proportional quantity of the whole mercury in the bulb of one thermometer being different from that in the other. This is valuable information, inasmuch as it will lead the way to an exposition of some of the errors and other defects of the instrument used in the science and mystery of thermometry, and therefore the case must be somewhat critically examined.

In shaping a question of such a nature, and especially in cases wherein mathematical truth is in requisition, precision of expression is indispensable; but the ten lines subscribed with the above initials, exhibit a confusion of idea, enough to swamp the inquiry ere it has reached incipience; therefore, before meddling with the subject, we will clear off the cobwebs with which it is entangled.

There are two methods of obtaining the temperature sought: the one, by finding the point at which melted wax (not melting wax) becomes solid; and the other, by finding the point at which melting wax, by increase of temperature, becomes fluid. The two cases "H. R." has confounded together, whereas, as will be seen afterwards, they are liable to differ according to circumstances. Hence two distinct questions are to be tried instead of one, and hence the necessity of discrimination between melting and melted wax.

It must also be noticed, that by the averment of "H. R.," the different results obtained, arose from the circumstance, that the bulb of the thermometer only was immersed, and from the *proportional* quantity of *the whole* mercury in the bulb of one thermometer, being different from that (*the proportional quantity*) in the other. To free this sentence from its obscurity, the words in italics must be obliterated, for the proportion of mercury in the bulb is the same whatever be its diameter, viz., as the cube thereof,—therefore, the different results have arisen from the different quantities of mercury contained within the respective bulbs, and not from the difference of the proportional quantity. Such casualties of expression are fair specimens of the confused notions which are too prevalent in the writings of philosophers, mathematicians, and mechanics of the present era; and I take advantage of this short digression to say, that I hope the editor of *this* journal will follow up the subject commenced under the title of "The Literature of Engineering," so that, in time to come, words may go hand in hand with the writer's intentions, and a straight story laid before the reader.

To enter on the general merits of the question:—First, The principle of the thermometric scale, whether of Celsius or Fahrenheit, is not mathematically correct, as proved in Note 1, subjoined; consequently, an *exact* rule cannot be given for finding the *true* point required from the observed or apparent one.

* Inven. Advo. vol. v. p. 19.

Second, Exclusive of the error shown in Note 1, the principle of the scale of every thermometer in present use is further defective, insomuch that the index has no relation to the pressure on the matter, of which the temperature is derived; consequently, different results will be obtained, as the pressure of the atmosphere on the matter (wax for example) may be greater or less, at the time of each experiment. (See Note 2.)

The answer to the inquiry, which will be of the greater utility, is as follows:—The less the diameter of the hulb of the thermometer, the nearer will two experiments agree in result; one being to determine the degree of temperature at which melted wax becomes solid, and the other the degree at which melting wax becomes fluid. The rationale of the case is, that the surface of a bulb is proportionate to the square of its diameter, and its contents to the cube; consequently, the heating and cooling surface is proportionate to the square of the diameter, and the mercury to he heated or cooled is proportional to its cube.

The temperature of the wax is constantly varying, so that, in no two infinitesimal particles of time, does its temperature continue the same; hnt time must elapse before the temperature of the mercury, at and near the centre of the bulb, is the same as that of the bulb in contact with the wax; therefore, in an experiment, when the temperature of the wax is decreasing, the scale will indicate a greater degree of temperature, than the true temperature of the wax, and *vice versa*, when the temperature of the wax is increasing. From the premises, it is evident that the greater the diameter of the bulb, the greater will he the difference between the true temperature of the wax, and the temperature as indicated on the scale. It follows, that if the same instrument be employed in each pair of experiments, an arithmetic mean between any two is a near approximation to the true temperature at which solid wax melts, or melted wax hecomes solid, provided the pressure of the atmosphere is always the same.

The proof of the preceding remarks is as follows: Let the room in which another experiment is about to be made, he raised to the temperature corresponding to the arithmetic mean as found, less 1°. Then, let the wax be gradually heated, the pressure of the atmosphere heing as in the former experiments, and the hulh of the instrument as small in diameter as admits of its heing practically useful, and the result of sueh experiment will agree with the arithmetic mean of the two former experiments. The same result will ensue, in case of the room being heated 1° above the point at which melted wax hecomes solid.

From the errors of the thermometer which have heen proved, and its defection in indicating a constantly varying temperature, it would be a waste of time to notice the position of the bulb upon the scale, which is part of the data; and the same ohservation applies to furnishing a rule, to correct the apparent or ohserved point at which melted wax becomes solid, or *vice versa*, according to the temperature of the room and the position of the bulb conjointly. But there are other matters for consideration hefore the instrument has reached that perfection which it should possess for minnte philosophical inquiries.

15 *Goulden Terrace, Islington, Nov.* 12, 1848. JOHN CURR.

[We have shown this letter to our correspondent, "H. R.," who has returned us the following answer to it.—ED. P. M. J.]

I feel obliged hy your handing me Mr. Curr's answer to the query with which I troublcd you regarding the point on the thermometric scale at which melted wax hecomes solid. My note was written *currente calamo*, and certainly requires correction in so far as "melting" should have heen "melted." Upon this error Mr. Curr is unnecessarily severe, for it is so obvious that it could mislead no one.

It is quite true that the melting point of a hody may be ascertained in either of two ways—viz. by ohserving the temperature at which, when melted, it becomes solid—or again, that at which it passes from the solid to the fluid state. The query refers to the former only, and there is no confounding of the two methods, as Mr. Curr asserts.

The scutence which your correspondent has cleared of what he calls its obscurity, by striking out the words on which its meaning hinges, looks worse in its amended form than the "tragedy of Hamlet with the part of Hamlet left out;" for it not only ceases to express what was meant by it, but it makes a statement directly opposed to the very fact on whieh the query was based. After this unique emendation, we are gravely told such "*casualties of expression*" are fair specimeus of the confused notions which are too prevalent in the writings of philosophers, and which Mr. Curr is anxious to clear up. While I commend his zeal in the cause of science, I wish his future efforts more success than the present. The expressions have nothing of "easualty" in them, if by that phrase is meant "random application;" but I must say the sensc which they were meant to convey, has not escaped without casualty in Mr. Curr's hands, seeing it has had the misfortune to suffer in them au untimely extinction.

This gentleman tells us that the thermometric scale is not mathematically correct in principle, and subjoins a note with an arithmetical proof of this position, carrying his figures to the formidahle extent of sixteen places of decimals! Before undertaking so minute a determination as this, it would have been worth while to have had a vigorously exact principle to proceed on. Mr. Curr's principle is, that equal increments of temperature produce equal increments of volume at all points of thc thermometric scale. This, though practically correct withiu certain limits, will not reach the profundity of sixteen places of decimals. But supposing his ground in this respect unchallengeahly firm, it is singular that a calculator of such minute accuraey should have failed to notice that the diameter of the tube, as well as the diameter of the bulb, is smaller at low than at high temperatures; and if he had applied the necessary correction in this respect, the error which he detects in the *seventh decimal place* would have heen diminished to a still more microscopical degree of tenuity, or perhaps have vanished entirely. I shall not stop to investigate this very nice question, but, without splitting hairs in arithmetic, (for I intend the query as a mathematical one ouly,) I shall endeavour to state the case hypothetically, so as to obviate, if possible, Mr. Curr's objections to favouring us with a solution.

Suppose, then, "true temperature" to mean the indication of a mercurial thermometer when the whole instrument is equally heated;—suppose the barometrical pressure such that the iudications of the thermometer are affected by it uniformly;—suppose that there *is* such a thing as latent or coustituent caloric, in consequence of the absorption or dissipation of which there is an interval of sensibly uniform temperature while a body passes from a solid to a fluid state, or *vice versa*. And although this is contrary to Mr. Curr's doctrine, we may at least suppose it, as it happens to be an experimental fact. If that geutleman would stir a hasin of melting icc with a thermometer, he would prohably find the temperature stationary at 32°, long cnough to give time for examining the phenomenon with mature deliberation. Suppose, further, we have two thermometers, in one of which the freezing point immediately adjoins the bulb, and in the other is fivc or six inches distant from it: of these it may be said, with tolerable *certainty* of expression, that the one has a greater proportional quantity of its mercury in the stalk than the other has. Now, let observations be made with these thermometers on thc point at which wax solidifies. The mercury in the bulb will be at the temperature we desire to ascertain, while the mercury in the stalk will be at the temperature of the room—we shall suppose *exactly*. The indications of both thermometers will therefore be short of what we shall call the truc temperature of melting wax; but the thermometer, whose freezing point is distant from the bulb, will be more below the truth thau the other; inasmueh as it has a greater *proportional* part of its mercury at the temperature of the room. What I want, is a formula by whieh I may calculate what would be the indication of either thermometer if the whole instrument were at the temperature of the bulb. Will Mr. Curr favour me with this? H. R.

Note 1.—Let the diam. of the bulb at 0° Centigrade = 1 inch. Let the mercury expand in volume from 0° to 50° C. as 1 to 1·009, and from 0° to 100° C. as 1 to 1·018; also, let the lineal dilation of glass, within corresponding temperatures, be as 1 to 1·0004, and 1·0008.

The contents of the bulb will be—

$$\text{At } 50^\circ \text{ C.} = 1{\cdot}0004_3 \times {\cdot}5236 = {\cdot}5242285713615104 = a$$

$$\text{At } 100^\circ \text{ C.} = 1{\cdot}0008_3 \times {\cdot}5236 = {\cdot}5248576455800832 = b$$

The mercury in the bulb at 0° C. is $= 1_3 \times {\cdot}5236 = {\cdot}5236$ inch, which, at 50° C., would occupy (as 1 : 1·009 : : ·5236 :) ·5283124 inch = A; and at 100° C. it would be (as 1 : 1·018 : : ·5236 :) ·5330248 = B.

$$\text{Then A} - a = {\cdot}0040838286384896 = r,$$

$$\text{and B} - b = {\cdot}0081671544199168 = s;$$

r and s represent the respective quantities in decimals of an inch in the tube of the thermometer, at 50° and 100°, when at the same temperature as that in the bulb, and inasmuch as $\frac{s}{2}$ exceeds r, insomuch is the instrument defective in principle, when the tube is of uniform diameter, and each degree on the scale equal; the error heing, when the diameter of the bulb is 1 inch, ·0000002514285312.

Note 2.—To the canse described may be in part ascribed the great difference, found by different experimenters, in the dilation of mercury, as well as other fluids that are elastic, which difference, between the freezing and boiling points of water, is, according to Ure's Dictionary of Chemistry, as 50 to 59, or 18 per cent.

ON DIAMETERS AND CIRCUMFERENCES OF CIRCLES.

Mathematically speaking, the true ratio which the circumference of a circle bears to its diameter can never be calculated exactly; hecause, as the diameter increases, the remainders in the circumference (hitherto imperceptible) are enlarged and made visible, so that the ratio apparently increases, whereas, in reality, it only approaches nearer to the truth, and this will occur however far the operation is continued. So that the ratio has the nature of a circulating decimal, the truc value cannot be found, but the farther thc operation is prolonged the ncarer the sum approximates to the true amount, on account of the difference constantly diminishing. Practically speaking, however, the ratio is exactly determined: for, hy

duly proportioning the ratio to the diameter given, the difference can be made so small as neither to be measured nor perceived. From these premises I am enabled to lay down an easy rule for finding the circumference, true, in any case, to the nine thousandth part of an inch.

By means of the 128 places of decimals, calculated by M. De Lagni, the circumference to a circle whose diameter is more than millions of miles can be found. The following rule, however, will enable us to find the exact circumference in any case, by using only a certain portion of his figures. The rule is:—Reduce the given diameter into thousandths of an inch, and make the result the multiplicand; then, for the multiplier, take as many figures from the ratio, 3·141,592,653,589, &c., as the multiplicand contains: the product shall never vary more than nine thousandths of an inch from the true circumference, and may therefore be called exact.

EXAMPLES:

1. Given a diameter of 6 inches to find the circumference:—
6×1000=6000 then 6000×3·142=3142×6=18852; & 18852÷1000=18·852 inches=circumference; or, in practice, 18·85 inches is correct.

2. Supposing our earth to be a globe, 8000 miles in diameter, what is its circumference?—

8000 miles=506,880,000,000 thousandths of an inch;
then 506,880,000,000×3·141,592,653,59=31,415,926·535,9×50,688=1,592,410,504,252, & 1,592,410,504,252÷1000=1,592,410,504·252 inc. or, 1,592,410,504¼ inches=exact circumference, 25,132 miles, 1305 yards, 0 feet, 4¼ inches.

In the first example, the difference is only $\frac{3}{1000}$ inch; and, in the second, only $\frac{1}{1000}$ inch, which, in both cases, is inappreciable.

Nov. 18, 1848. T. C. T.

ON THE EFFECT OF DIMINISHED ATMOSPHERIC PRESSURE UPON CONDENSING STEAM-ENGINES.

We all know the practical effect of high or low atmospheric pressure on the working of condensing steam-engines; and therefore their situation, as compared with the level of the sea, will affect their power with the same consumption of fuel. Will you, or any of your readers, say in what ratio, or to what amount, the effect is produced? For instance, my engines are placed about 30 feet above the level of the sea, and I know others more than 1000 feet high.

Preston, Nov. 7, 1848. W. Taylor.

PHENOMENON ATTENDING THE DISCHARGE OF HIGH-PRESSURE STEAM.

Can any of your numerous scientific readers explain the cause of the following phenomenon?—On lifting the safety valve of a high-pressure boiler, after night, I discovered a white lambent light round the orifice of the valve. The steam in the boiler was about 30 lbs. to the inch.

Morrie Town, Devonport, Nov. 1848. Vincent Bird.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—EIGHTEENTH MEETING.—Swansea, Aug. 9.

Section F.—Statistics.

Facts bearing on the Progress of the Railway System, by Mr. W. Harding.

(Concluded from Page 191.)

First alteration.—In 1842, uncovered, open, third-class carriages, at a fare of 6*d.* for the 23 miles (or about ¼*d.* per mile) were introduced on the railway between Glasgow and Greenock, whereupon the annual number of railway passengers between those places increased 224,000, being an increase of 32 per cent. of the total number travelling (either by railway or steamboat). The number of first and second class fell off at the same time 30 per cent., the passengers having transferred themselves from the higher class carriages into the open third-class carriages, tempted by the difference of fares between ½*d.* per mile and ¼*d.* per mile. The gross receipts, however, increased simultaneously 15 per cent.; the working expenses on the other hand, did not appreciably increase, although the average number of passengers per train increased from 72 to 117. *Second alteration.*—The third-class fares were subsequently (in 1843) raised from 6*d.* to 1*s.*, with the hope of increasing the revenue. The whole number travelling by railway and steamboat immediately fell off 18 per cent. The first and second class railway passengers increased by 10 per cent., but the gross receipts fell off more than 10 per cent. The effect was also tried of making the third-class carriages more comfortable by covering them in. This was found not to increase the number travelling, but it did reduce the number of first and second class passengers by 16 per cent., and therefore caused considerable loss to the company. The same experiment was repeated on the second-class carriages: they were made more comfortable by inserting glass windows instead of wooden shutters, and by carrying the interior partition higher. The number of first-class passengers shortly fell off by 12 per cent., but beyond this the second-class passengers did not appreciably increase; this experiment, therefore, also resulted in loss. The results of these experiments were then—1st, That a reduction of fares to ¼*d.* per mile, even from so low a rate as ½*d.* per mile, increased the number travelling by nearly a quarter of a million, or by two-thirds of the whole population of the district. As these people were generally of the less affluent classes, it appears that they were actually drawn out of the noisome streets of Glasgow to the north of the Clyde by the temptation of a very low fare, and immediately that the fare was raised they were driven back again into the city. 2nd, That under the circumstances of the line in question, cheap and rapid travelling increased the number travelling; but improving the lower-priced carriages did not, however, appear to act in the same way, but merely tempted passengers from the higher class carriages—those from the second-class into the third-class carriages, and from the first to the second class;—of course, it by no means follows that similar results would ensue on lines in other localities; each case must be determined by its peculiar conditions. 3rd, That no limit can be assigned to the number of travellers which cheapening and quickening the means of conveyance will create. The introduction of the railway, even where steamboats already afforded a most pleasant, rapid, and cheap communication, increased, we see, the number travelling from 110,000 to 2,000,000,—2,000,000 being five times the whole population of the district. I doubt whether either at home or abroad so large a proportion of travellers to the whole population is to be found. The traffic between Glasgow and Paisley is probably the most remarkable instance on record of the increase of travelling caused by increased facilities. In 1814, there was only one coach a week between Glasgow and Paisley, conveying about 2,000 passengers per annum; if we multiply this by 5, to allow for the greater number of gigs and private vehicles then in use, we only get 10,000 passengers per annum conveyed between the two places. In 1842, the numbers travelling by public conveyance between Glasgow and Paisley were upwards of 900,000. Now, as the population between 1814 and 1842 had only about doubled itself, while the traffic, as we see, had multipled itself ninetyfold, it follows that the increased facilities of transport had increased the number travelling relatively to the population 45 times; that is to say, that for every journey which an inhabitant of Glasgow or Paisley took in 1814, he took 45 journeys in 1843. These results, I conceive, place it beyond a doubt, that we should spare no effort to make railway travelling cheap and within the reach of all classes.

Now there is only one true way of encouraging cheap travelling, and that is by keeping down the original cost, and the annual expenses of railways. All the other contrivances which the public are inclined to trust, such as legislative restriction on profits, and so on, are mere quackery. Even competition is inapplicable to railways, and is not to be relied on.* Mr. R. Stephenson, the engineer, put the whole case into one sentence when he said, to have combination is practicable, competition is impossible. The experience of all railway competition shows that this is true; when, therefore, under the plea of competition unnecessary outlay is being incurred, the public may rest assured that they will ultimately suffer for it in the charges they will have to pay.

Mr. Hill Williams, the actuary, has compiled some useful † tables, to show arithmetically, "how far a remunerative charge for the conveyance of passengers and goods on railways is modified by the original cost" and other circumstances.

The following is an extract showing the effect of increased cost of construction:—
Total yearly traffic, number of passengers or tons of goods, 90,000.

	Original cost of Construction £15,000 per mile.	Original cost of Construction £20,000 per mile.	Original cost of Construction £25,000 per mile.	Original cost of Construction £30,000 per mile.
Fixed charge per mile on every passenger or ton of goods requisite in order to give common interest, 5 per cent. on the outlay.	D. 1·00	D. 1·33	D. 1·66	D. 2·00

We see from this that the fixed charge on every ton of goods or passenger must average 2d. per mile to return common interest on a railway costing £30,000, whereas, if the railway cost £20,000, 1½d. per mile would be sufficient, and if it cost £15,000, 1d. per mile would be sufficient.

After a series of similar investigations, the author concludes as follows:—The result of the preceding inquiry is, it appears to me, on the whole, satisfactory. The railway system has doubled itself in the last three years. Fares have been greatly reduced. Third-class passengers have largely increased. The importance and value of the traffic in goods and cattle relatively to the passenger traffic have become more apparent. The number of trains is greater, and the speed of some of the trains has been accelerated; and all this has been effected without any falling off in the average receipts on each mile of railway in working, but with an increase probably sufficient to meet the increase of the working expenses attendant on the increased accommodation now afforded by railways: whatever falling off in dividends there may have been, is, therefore, to be attributed in a general view of the subject to the capitalization of loans and the creation of fictitious capital by the purchase of railways at premiums, and, therefore, at sums beyond what they actually cost. These being profitable speculations when shares were high, were pushed to such an extent as now to press severely on the original share capital of railway companies. The great evil of the last three years is the extravagant outlay of money which has taken place; an outlay which, instead of being checked by the legislature, has been encouraged to the utmost by the mode of inquiry adopted. This has inflicted on the railway system a burden which it will never be able to throw off, and which the public will always have to bear with them in a higher rate of charge for conveyance than would with common prudence have been necessary. It only remains to stop

* Evidence Select Committee on Railway Act Enactments, 1846.
† Appendix No. 7, Select Committee on Railway Act Enactments, 1846.

tbe extravagance with a strong hand. The very existence of the railway companies depends on the economy they can practise in making and working their railways; and nothing which on the face of it involves increased outlay, be it diversity of guage, and its consequence the mixed guage, or the more plausible plea of competition, should be countenanced either by railway companies or by the legislature, if we wish to secure for ourselves the full fruits of that admirable invention, which England and English engineers, who have followed in the steps of George Stephenson, have given to the world.

SECTION G.—MECHANICAL SCIENCE.

"On a Low-Pressure Atmospheric Railway," by Mr. W. P. Struve.—After having described the various plans of applying atmospheric pressure to the purpose of railway transit, from that of Vallance in 1824 to the present extensive experiment on the South Devon Railway, the writer pointed out the great difficulty which existed of communicating the interior motion of the piston in the tube to the train outside: that, in order to do this, it became necessary to have a slit or opening along its whole length, which is closed by an elastic valve, rendered tight and impervious to air by a composition of fatty matter placed in the groove in which the valve falls. The difficulties, however, which had to be contended with on account of the leakage along the valve and piston were very great. He went on to state—The plan by which I propose to obviate these difficulties is, to make a covered viaduct of the railway for the purpose of passing the train through. The sides to be constructed of masonry, and the top of timber or any other materials that may be found equally convenient. The piston to be a shield fixed on wheels made to fit the covered way; but allowing a sufficient space round its outer edge, so that it may pass along without touching the interior surface of the passage. As the rarefaction required to urge the train through would be very little, not much importance need be attached to the leakage: a covered way of 9 feet square, equivalent to 81 superficial feet at a pressure of $\frac{6}{10}$ of a pound to the inch, would amount to 3 tons, or four times the pressure which was obtained on the Croydon Railway. The train of carriages would thus pass through a covered way, which may be lighted through glass. As valves in the shield may at any time be opened, so as to diminish or remove the pressure, the train may be slackened or stopped at any point. The advantages of this plan appear to be increased speed, safety, and economy; also the resistance of the air in front of the train will be diminished, and no stoppages can be occasioned by a snow-drift or frost. The system also possesses all the advantages claimed by the promoters of the other mode of atmospheric traction. I propose to exhaust the tube by means of two large chambers constructed like gasometers, moving up and down in water by means of a steam-engine, which need not be stopped, as the regulation of the speed and the stoppage of the trains would be effected by opening the valves in the shield, or the doorways at the stations. Each station would be provided with a loop-line so as not to destroy the continuity of the covered way, and the trains would then run into open sheds at each station for the purpose of receiving and taking out the passengers. The cost of the covered way and apparatus for exhausting, will, in ordinary cases, not exceed £7,000 per mile: which is not more than the usual cost of locomotive engines, and the extra weight of rails required for their support, nor more than the cost of the present atmospheric railways. A working model, 20 feet long, was exhibited, and the subject generally excited much interest.

MONTHLY NOTES.

CONCENTRIC BALLS OF THE CHINESE.—In the last number of the *Athenæum* is a notice, extracted from *The Builder*, of a supposed discovery of the method of forming Chinese balls, founded upon a cleavage of the balls caused by the application of heat and steam. Upon this I have to remark,—first, that, in a substance which is not totally free from *grain* or lamination, the production of a very regular cleavage by heat and steam is no proof that the surfaces have ever been separated before; and, secondly, that there is no necessity for the supposition that the balls have been made in parts,—as I now proceed to show. In all the Chinese balls it will be remarked, that a large proportion of each of the inner shells is removed by large circular holes. Into each of these holes a tool may be introduced in form like the letter L; the stout stalk or upright stroke of the L (which may be of any length) being intended only for the convenience of holding, and the thin horizontal stroke of the L (which is the cutting part of the tool) being slightly bent downwards for the curvature of the spherical shell, and being determined in length only by the diameter of the hole into which it is introduced. The ball then being mounted on a lathe, it is evident that, by means of this tool, the shell may be undercut on all sides to an extent equal to the free length of the tool, or nearly equal to the diameter of the hole. Thus, if there were a hole one inch in diameter, a tool might be introduced whose whole length (corresponding to the thin stroke of the L) is one inch, and whose free length is perhaps $\frac{7}{8}$ of an inch; and by means of this the shell will be undercut in a circle whose diameter is $2\frac{3}{4}$ inches. If, then, the holes are so near to each other that the large circles thus cut will cover the whole surface, the inner ball will be completely detached from the exterior shell. I lately examined a Chinese ball, in which there were at first sight visible externally only three large holes. But upon closer examination it was discovered that there were a number of holes of the same size plugged up. Luckily, the external shell had been injured by a violent blow; and I was thus enabled to examine with the utmost accuracy the nature of the plugging. In one part a plug had been broken away and lost, leaving visible the ring into which it had been inserted; in another part the ring was partly broken away, leaving the edge of the plug visible. The plugs are screwed into the rings with the most strongly-cut screw that I have ever seen,—the depth of the thread exceeding the interval between two threads. (The Chinese must be possessed of good screw-cutting tools, and of great skill in the use of them.) The plug has a flat brim or verge, so that it is screwed down to a shoulder-bearing. Upon examining the ball in detail, I found eleven holes thus plugged up,—making in all fourteen holes. Then, upon actually measuring the diameters of these holes and the distances between adjacent holes, I found that all parts of the sphere were abundantly covered by the circles which could be undercut by the use of such a tool as I have described. As far as I could discover, the holes in the inner shells corresponded to those on the outer shell, in position and in proportion of their diameters to the diameters of their spheres; and thus each of these spherical shells could be undercut in the same manner for detaching the sphere within it,—each shell, for the most part, requiring a different tool. The process, then, by which Chinese balls *may be* made, and by which I conceive they *have been* made, is the following:—1. The block of ivory is turned to a spherical form. 2. A number of conical holes are drilled into the sphere, the vertices of the cones being at the centre of the sphere, and the centres of the bases of the cones being in any symmetrical arrangement which will bring the holes near enough together. At the same time, any part of the tracery work, which is common to all the shells, is drilled nearly to the centre. 3. A set of tools of the form of the letter L is prepared, one for each shell; the length of the stalk and its stop being adapted to the distance of that shell from the exterior, and the length of the cutting part being nearly equal to the diameter of the conical hole at that shell. 4. The perforated sphere is chucked upon a common lathe—the chuck being conical, adapted to any of the conical holes. The tool with the longest stalk is introduced into the hole opposite to the chuck (being supported on a cross-rest), and the innermost sphere is undercut, so as to detach in part the central block. The sphere is then chucked by another hole, and the process is repeated, till, after the last undercutting, the central block is completely detached. 5. In like manner the second shell (measuring from the centre) is undercut by the use of another tool, until the first shell is completely separated both from the central block (by the former operation) and from the second shell (by this operation). Then the tracery of the first shell is cut; the drills and other cutting instruments being introduced through the large holes, and the first shell being turned about so as successively to expose all parts of its surface. 6. After this, each shell successively, from the centre to the exterior, is detached in the same manner, and its tracery is cut. 7. Possibly it may be advantageous, for the steadiness of the support on the chuck, to block some of the holes not occupied in the turning process, each by a conical block; or a ring-support may act in the inside of the external hole opposite to the chuck. 8. The final operation, after undercutting the external shell and cutting the tracery of the shell next to it, will be to plug as many holes as may be thought necessary, and to cut the tracery upon the whole external shell.—A. B. G.—*Athenæum.*

ENGLISH PATENTS.

Sealed from 26th October, 1848, to 16th November, 1848.

William Brown, Cambridge Heath, Middlesex, weaver,—"Improvements in manufacturing elastic stockings and other elastic bandages and fabrics."—October 26th.

Soren Hjorth, Jewry-street, Aldgate,—"Certain improvements in the use of electro-magnetism, and its application as a motive power, and also other improvements in its application generally to engines, ships, and railways."—26th.

James Clark, Glastonbury, Somerset, manufacturer,—"Improvements in the manufacture of boots, shoes, and clogs."—26th.

William Longmaid, Beaumont-square, Middlesex, gent.,—"Improvements in treating the oxides of iron, and in obtaining products therefrom."—26th.

William Church, civil engineer, and Thomas Lewis, woollen draper, Birmingham,—"A certain improvement, or certain improvements in machinery, to be employed in making playing and other cards, and also other articles made wholly or in part of paper or pasteboard, part or parts of which said machinery may be applied to other purposes where pressure is required."—26th.

Peter Fairbairn, Leeds, York, machine maker,—"Improvements in machinery for heckling, carding, drawing, roving, and spinning flax, hemp, tow, silk, and other fibrous substances."—26th.

James Barrows, Haigh, near Wigan, Lancashire, engineer and draughtsman, and George Holcroft, Manchester, consulting engineer,—"Certain improvements in, and applicable to, steam-engines, in the machinery or apparatus belonging thereto, in the construction and arrangement of boilers for the generation of steam, and in the furnaces and flues used in connection therewith, parts of which improvements are also applicable to other similar purposes."—26th.

Alfred Vincent Newton, 66, Chancery-lane, mechanical draughtsman,—"Certain improvements in the manufacture of steel."—November 2.

Charles William Kesselmeyer, Manchester, warehouseman, and Thomas Mellowdew, Oldham, in the same county,—"Certain improvements in the manufacture of velvets, velveteens, and other similar fabrics."—2d.

Charles Dawson, Hardinge-street, Islington, professor of music,—"Certain improvements in musical instruments, and in apparatus to be used in connection with musical instruments."—2d.

Robert Thomson Pattison, Glasgow, printer,—"An improved preparation or material for fixing paint or pigment colours on cotton, linen, woollen, silk, and other woven fabrics."—2d.

James Hart, Bermondsey-square, engineer,—"Improvements in machinery for manufacturing bricks and tiles, parts of which machinery are applicable to moulding other substances."—2d.

William Weild, Manchester, mechanical draughtsman,—"Certain improvements in machinery for spinning cotton and other fibrous substances."—2d.

Richard Bright, Bruton-street, Middlesex, lamp-manufacturer,—"Improvements in lamps, wicks, and covers for vessels for holding oil and other fluids."—2d.

Robert Walter Winfield, Birmingham, manufacturer,—"Certain improvements in the construction and manufacture of metallic bedsteads, couches, and sofas."—2d.

John Harris, Richard's-terrace, Rotherhithe, Surrey, engineer,—"A mode or modes of founding type, and of casting in metal, plaster, and certain materials."—2d.

James Robertson, Liverpool, cooper,—"A mode or modes of consuming smoke and other gaseous products arising from fuel and other substances."—2d.

Richard Archibald Brooman, Fleet-street, London, gentleman,—"Certain improvements in the manufacture of hinges, and the machinery or apparatus used therein."—(Communication.)—2d.

William Bullock Tibbets, Braunston, Northampton, gentleman,—"Improvements in obtaining, applying, and controlling motive power, parts of which improvements are applicable to the raising and forcing of liquids."—2d.

Francis Gybbon Spilsbury, St. John's Wood, gentleman,—"Improvements in paints and pigments."—2d.

George Arthur Biddle, Ipswich, engineer,—"Improvements applicable to gas-burners."—2d.

Meyer Jacobs, Spitalfields, Middlesex, gentleman,—"Certain improvements in the manufacture, stamping, and treatment generally of woven fabrics of all kinds."—2d.

Thomas John Knowlys, Heysham Tower, near Lancaster, Esq.,—"Improvements in the application, removal, and compression of atmospheric air."—2d.

George Henry Bachhoffner, Royal Polytechnic Institution, London, Doctor of Philosophy, Professor of Natural Philosophy,—"Improved means of transmitting, communicating, or conveying intelligence."—4th.

Joseph Cooper, Walworth, tailor,—"Improvements in fastenings for wearing apparel."—4th.

Charles Iles, Birmingham, machinist,—"Improvements in the manufacture of certain descriptions of dress-fastenings, and in the making up of dress-fastenings and other articles for sale."—4th.

Henry Kempton, Pentonville, Middlesex, gentleman,—"Improvements in reflectors and apparatus for artificial light."—7th.

Moses Poole, London, gentleman,—"Improvements in machinery for making nails."—(Being a communication.)—7th.

James Napier, Swansea, operative chemist,—"Improvements in the manufacture of copper, and other metals and alloys of metals."—9th.

Richard Coad, Kensington, Surrey, chemist,—"Improvements in the construction of blast and other furnaces and fire-places."—9th.

James Andersou, Abbotsford-place, Glasgow, starch manufacturer,—"A certain improved mode of separating the different qualities of potatoes and other vegetables."—11th.

Alexander Parkes and Henry Parkes, Birmingham,—"Improvements in the manufacture of metals and alloys of metals, and in the treatment of metallic matters with various substances."—11th.

John Browne, Osnaburgh-street, Middlesex, gentleman,—"Improvements in fire-escapes, and in apparatus to facilitate persons employed in cleaning windows."—11th.

Alexander Balfour, Dundee, Scotland, leather merchant and manufacturer,—"Improvements in apparatus for cutting metal washers and other articles, and in the construction of buffers."—16th.

Samuel Adams, West Bromwich, Stafford, organist,—"Improvements in mills for grinding."—16th.

William Wilkinson, Yarrow, near Gateshead, Durham, coke manfacturer,—"Certain improvements in the construction of coke oveus, and in the machinery or apparatus to be connected therewith."—16th.

SCOTCH PATENTS.

Sealed from 25th October, 1848, to 20th November, 1848.

John James Cole, Lucas-street, Middlesex, engineer,—"Certain improvements in steam-engines."—October 25th.

Harry Joseph Perlbach, Hamburgh, founder,—"Improved method or methods of uniting certain metals or alloys of metals."—25th.

Peter Fairbairn, Leeds, York, machine maker,—"Improvements in machinery for heckling, carding, drawing, roving, and spinning flax, hemp, tow, silk, and other fibrous substances."—30th.

Joseph Eugene Asaert, Lille, in the Republic of France, machinist,—"Improved means of obtaining motive power."—30th.

Isaiah Davies, Birmingham, Warwick, engineer,—"Improvements in steam-engines and locomotive carriages, parts of which are also applicable to other motive machinery."—31st.

Thomas John Knowlys, Heysham Tower, near Lancaster, Esq., and William Fillis, Shirley, Hants, mechanician,—"Improvements in generating, indicating, and applying heat."—November 6th.

Henry Bessemer, St. Pancras-road, Middlesex, engineer,—"Improvements in the manufacture of glass."—6th.

Charles Green, Birmingham, Warwick, patent brass tube manufacturer, and James Newman, Birmingham, opificer,—"Improvements in the manufacture of a part or parts of railway wheels."—14th.

Thomas John Knowlys, Heysham Tower, near Lancaster, Esq.,—"Improvements in the application, removal, and compression of atmospheric air."—14th.

Thomas Gill, and John Edgcumbe Gill, Plymouth, manufacturers,—"Improvements in the manufacture of manures."—15th.

Alfred Vincent Newton, Office for Patents, 66, Chancery-lane, Middlesex, mechanical draughtsman,—"Certain improvements in the manufacture of steel."—(Being a communication.)—20th.

George Remington, Warkworth, Northumberland, civil engineer,—"Improvements in locomotive engines, and in marine and stationary engines."—20th.

IRISH PATENTS.

Sealed from 20th October, 1848, to 20th November, 1848.

William Sager, Rochdale, Lancaster, wool dealer,—"Certain improved means and apparatus for effecting the transit or conveyance of goods, passengers, and correspondence, by land or water, and for other such purposes, part or parts of which means and apparatus constitute a new and improved method of generating steam, which improvement is applicable to other purposes to which steam is generally applied as a motive power."—October 28th.

John Miller, Henrietta-street, Covent Garden, Middlesex, gentleman,—"New system of accelerated menattrite locomotion, even by aniual impulsion, for every species of transport machines acting by means of wheels, whether on land or water."—(Being a communication.)—28th.

Henry Highton, Rugby, Warwick, clerk, master of arts, and Edward Highton, Regent's Park, Middlesex, civil engineer,—"Improvements in electric telegraphs."—November 8th.

Peter Fairbairn, Leeds, York, machine maker,—"Improvements in machinery for heckling, carding, drawing, roving, and spinning flax, hemp, tow, silk, and other fibrous substances."—11th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 19th October, 1848, to 15th November, 1848.

Oct. 19th,	No. 1627.	C. Rowley, Birmingham,—"Handle for umbrellas, parasols, and walking-sticks."
—	1628.	Benjamin Verity, King-street, Covent-Garden, and J. C. Haddan, Lincoln's Inn-fields, London,—"Gas-burner."
—	1629.	Henry Pershouse, Birmingham,—"Inkstaud."
20th,	1630.	W. B. Moffatt, Spring-gardens,—"Diaphragm double sewer for separating or combining house drainage and surface drainage."
—	1631.	Joseph Rogers and Sons, Sheffield,—"Spring-tang table knife."
—	1632.	Stephen Green, Princes-street, Lambeth,—"Parts of a water-closet."
21st,	1633.	William Kirkwood, West Thistle-street-lane, Edinburgh,—"Piston-cock."
—	1634.	William Southam, the Mills, Nuneaton,—"Self-acting air-conductor and ventilator for mill-stones."
23d,	1635.	Ellis Rowland, Belfast,—"High-pressure steam guage and self-acting blast regulator."
—	1636.	John Roberts, Eastcheap, London,—"Horticultural double tile."
Oct. 23h,	1637.	John Thomas Tucker, Exeter,—"Universal brooch-protector."
—	1638.	James Dubois, Paulton-terrace, King's-road, Chelsea,—"Annulus scapus, or elastic ferule or wrapper for taps."
—	1639.	Bourjeaurd, Davies-street, Grosvenor-square,—"Elastic suspensor."
—	1640.	J. A. Barnett, Salford,—"Treble symbolic indicator."
25th,	1641.	Charles Parker, Brmingham,—"Whip-holder."
26th,	1642.	Richard Walker, Birmingham,—"Fastening for dress."
27th,	1643.	William Bowler, Manchester,—"Ventilation hat tip."
28th,	1644.	John Mather, Newcastle-on-Tyne,—"Stove."
—	1645.	William Edward Jenkins, Broad-street, Golden-square,—"Preserver envelope."
31st,	1646.	W. Burbury, Leamington,—"Safety carriage, to prevent horses from falling."
—	1647.	Richard Eede Marshall, Cheltenham,—"Clip and file for holding letters, papers, and pamphlets."
Nov. 2d,	1648.	William Reid, 51, Conduit-street,—"Sans-pli shirt, without gathers."
—	1649.	Spilsbury, Butler, and Co., Birmingham,—"Cooking, roasting, and baking apparatus."
3d,	1650.	William Ramsay, Hull,—"Elastic seat for a saddle."
—	1651.	Thomas Edwards, Charing Cross,—"Military folding dressing-glass."
—	1652.	Thomas Edwards, Charing Cross,—"Camp and cabin shaving-glass."
4th,	1653.	David Harvey, Admiralty and Somerset House,—"Safety disconnecting plate for locomotive or any other railway carriage."
—	1654.	John Inderwick, Princes-street,—"Egyptian treble cylinder-pipe."
7th,	1655.	William Tanner, Islington,—"Dial-plate for time-keepers."
—	1656.	Willis and Co., St. James's-street,—"Australian mantle."
—	1657.	Christopher Hill, New Swindon, Wiltshire,—"Covering for wagons."
—	1658.	Robert Allason, Sunderland,—"Sifting-shovel."
—	1659.	Humphries and Thirst, Chelsea,—"Flap-valve for sewers."
—	1660.	Thomas John Bingent, York-street, St. James's,—"Spring clothes peg."
—	1661.	John Storrie, Chapham-road,—"Storrie's knife-board."
8th,	1662.	Henry Moise, Holborn,—"File or holder for newspapers."
—	1663.	John Roberts, Eastcheap,—"Flower supporter."
—	1664.	George Caster Haseler, Birmingham,—"Brooch-fastening."
13th,	1665.	Thomas Taylor, Manchester,—"The scarf wrapper vest."
—	1666.	Benjamin Nicoll, Regent-circus,—"Shirt."
14th,	1667.	William Evans, Baubury,—"Mangle."
15th,	1668.	Henry John Nicoll and Donald Nicoll, Regent-street and Cornhill,—"Wrapper coat, and feet protector."

TO READERS AND CORRESPONDENTS.

Books Received.—"The Physical Properties of Steam," by John Curr. "Every Man his own House-painter," by P. Vanherman. "Theoretical and Practical Mechanics," by James Hann. "English Pleasure Carriages," by W. B. Adams. "The Architect, Builder, and Contractor's Pocket-Book." "Tredgold on the Steam-Engine," for October and November, new edition. "The Twentieth Annual Report of the Preston Institution for the Diffusion of Knowledge."

R. G. Aberdeen.—Upon calculation, we find some 9 feet difference, not 77, as he has it. This has, no doubt, been occasioned by a misprint; but as the data for obtaining the true surface are given, we do uot see that any one can be led far away by it. We are obliged by his pointing it out.

G. O. D.—The Encyclopædias will furnish him with all the information on the subject which is in print. There are several works on music and musical instruments. Should we find anything in them to suit his purpose, we will let him know.

Ma. Wilson, London.—We are obliged by his polite attention, which, he will see, we have turned to account.

B. E. N.—This peculiarity is well known to all really practical men, who are aceustomed to set their valves accordingly. Has he met with parties who do not know it?

Mr. Mills.—We have attended to his request. Should he require further assistance, he may obtain it by addressing a communication to the *Patent Office, 33 Buchanan-street, Glasgow.*

J. Burrows.—We shall be glad to have the drawings and particulars, if supplied in due time. He will certainly be at liberty to make what use of them he thinks proper *afterwards.*

J. Beveridge.—His communication was despatched, as requested, on the 20th ult. Does he wish to have the remainder?

J. L.—We intend to say something on the subject when time will allow. Other engagements have hitherto retarded us. The Professor's plan is a good one.

C. Hill.—Next month.

D. Harvey.—We wait the arrival of the particulars.

Messrs. H. and T. Chelsea.—We are obliged by their communication, which shall be kept in view.

Mr. Dempster.—Has he got our letter? We are compelled to lay the subject aside until next month.

Orthography.—If our reputation rested on so narrow a base, we doubt not that it would, many times ere now, have toppled over. Of three metropolitan journals, each has a different method of spelling the word—showing a rather extraordinary disagreement of doctors. We suppose his very threadbare French phrase is intended as an example of his lingual powers. Had he not better correct his English syntax first? Did we not think his remarks proceeded from good motives, we should deem them the reverse of pertinent.

S. H. London.—At what date will the communication be made? To insure care and accuracy it should be an early one.

F. Pastorelli.—We owe him our thanks. Other matters have prevented our notice of the apparatus this month.

T. D. Ardee.—We have referred the inquiry to our agent in London, who will communicate with him.

J. A. P.—If possible, we will attend to his request next month. So far, we are douhtful as to the economy of the process.

A. B. London.—He is quite right in directing our attention to the matter, which has arisen in the way he points out. A note would certainly have cleared up the expression.

Ma. Dubois, London.—Will he favour us with the official description and drawing?

J. Brook, London.—His letter was too late to receive much attention. We believe the time is undetermined. Next month we may inform him more accurately.

Mr. Taylor, Preston.—Our notes on the cement have been kept out this month by other matter. It will give us more time to devote to the subject in December.

Mr. Poole.—Has he received our letter?

Ma. Owen.—He will see that we have attended to his recommendation.

J. Pease.—Will he forward us the tables?

R. E. Marsham.—We shall attend to the article when it arrives.

J. Baook, Leeds.—An hour's study of the lever, in connection with an examination of the "steel-yard valve," will put him in possession of the information he desires, with far less trouble to himself, than it would cost us to sit down and write an essay on the subject for his individual benefit.

☞ Several letters, &c., lie over for want of room.

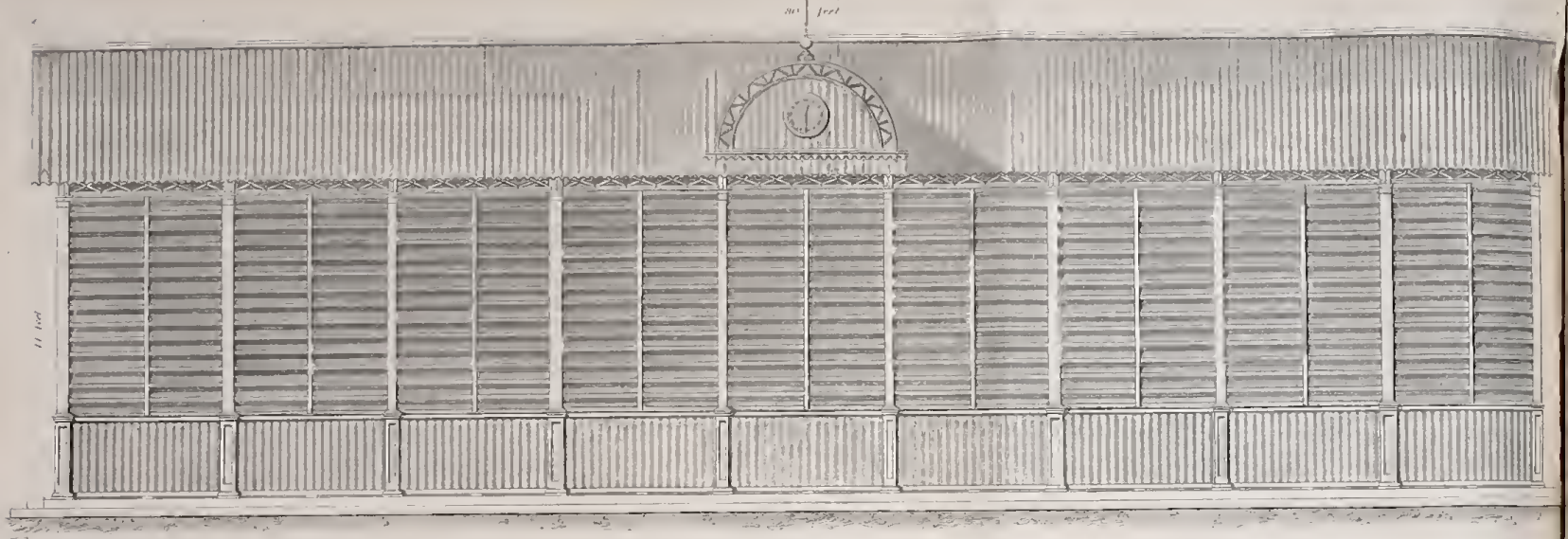
Plate XVI

IRON MARKET HOUSE

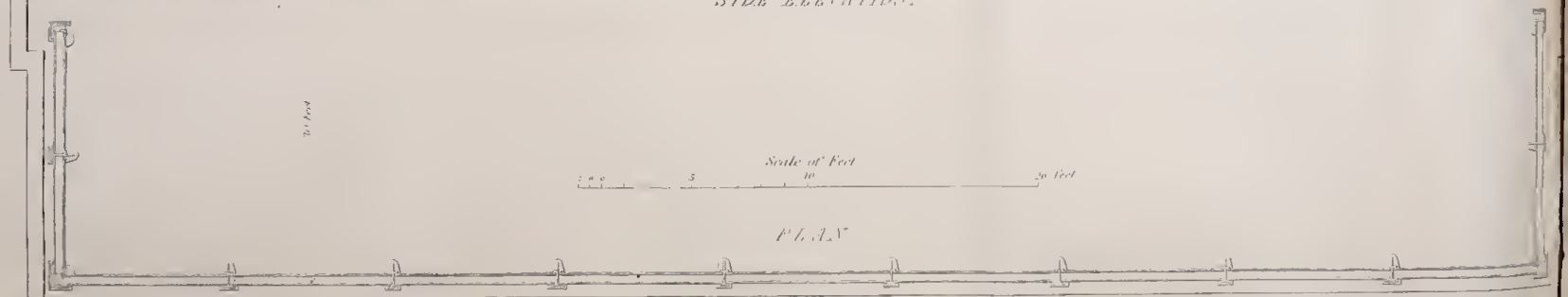
AT SAN FERNANDO, TRINIDAD.

J H Porter Esqr. | Engineer London

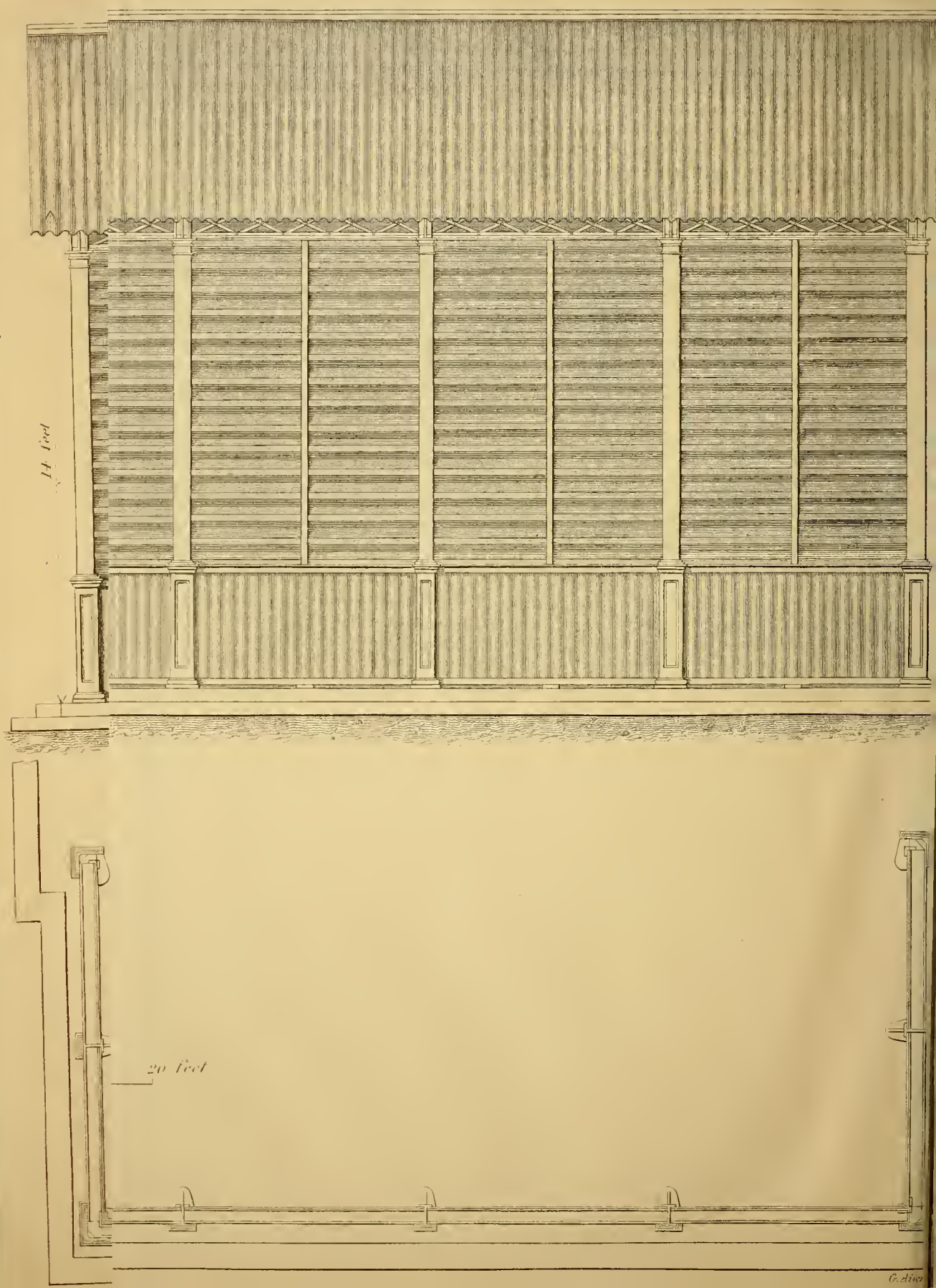
Vol I



SIDE ELEVATION.



PLAN


14 feet
20 feet

IRON MARKET HOUSE AT SAN FERNANDO.

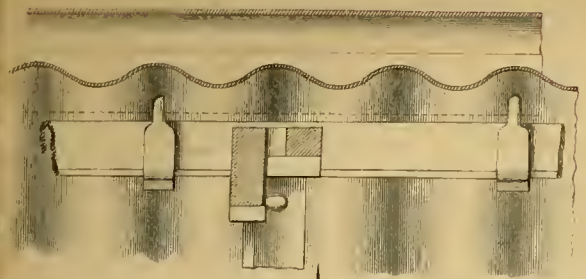


Fig. 1.

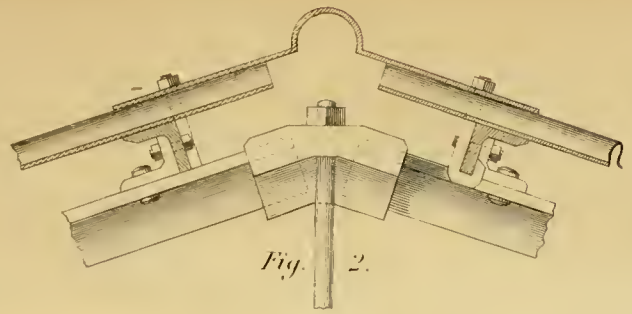


Fig. 2.

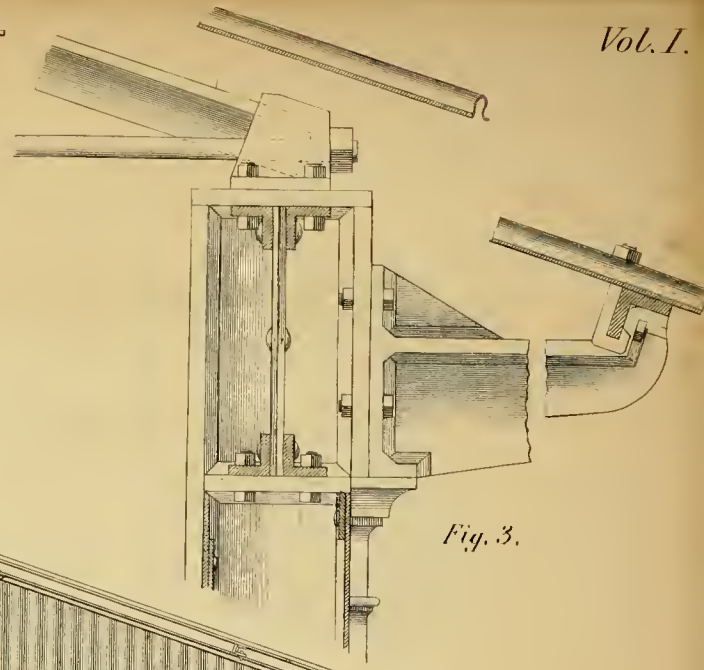
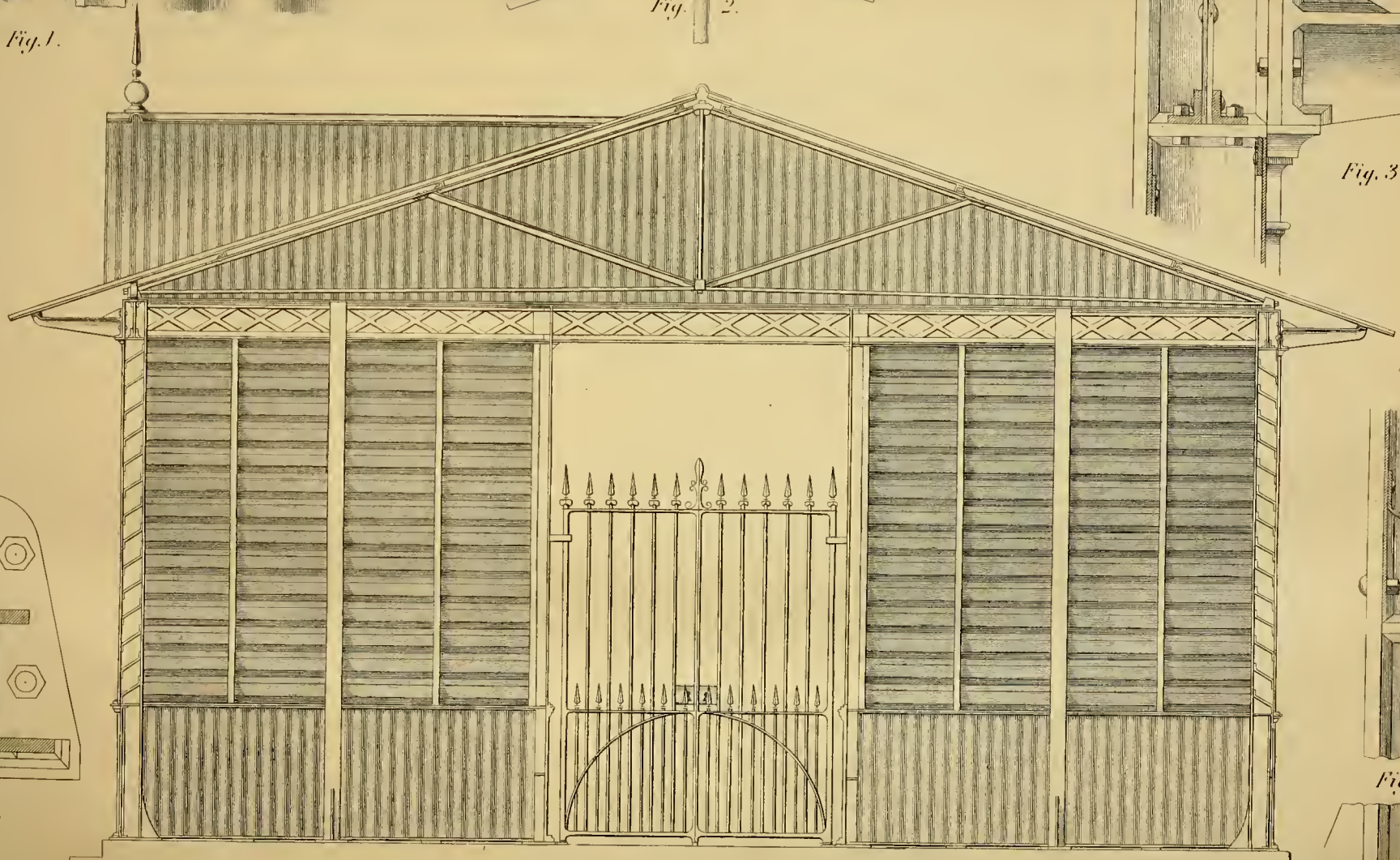


Fig. 3.



TRANSVERSE SECTIONAL ELEVATION.

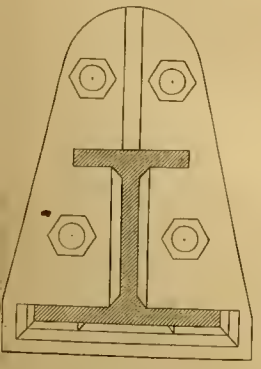


Fig. 5.

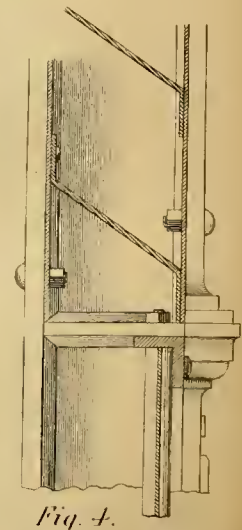
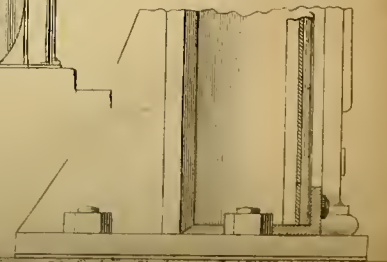


Fig. 4.



Scale

12 6 0 5 10 Feet

W. Johnson

NOTES OF A SOUTHERN JOURNEY.

RAILWAY TRANSIT—THAMES STEAMERS—PARIAN CEMENT—REGENT STREET COLONNADE.

Professional business having called us, a few weeks ago, to the metropolis, we have followed the fashion of the day in sketching out a few of our impressions of the journey, and the notabilia we met with, in a brief inspection of the progress of southern engineering, and its collateral pursuits. Of course, mere general ideas only can be gathered in a running journey like ours, and we relate them simply as "incidents of travel." Locomotion has become such a matter-of-fact affair, that it leaves little or nothing to tell of its adventures; and the residents of opposite extremities of the island may interchange visits with hardly a notion to communicate relative to their conveyance. To the Caledonian and North British railways we owe many of the benefits and comforts arising from this facility of intercourse, for they have shortened the way, and have virtually added to the extent of our lives, by reducing the amount of time extravagantly spent in travelling slowly.

After quitting Glasgow, the entire route to London is already as direct, and costs as little trouble to the traveller, as can be well expected; but the inhabitants of this city have still to complain of inconveniences and difficulties in getting to their line of conveyance in a southward direction. The station of the old established Garnkirk line, originally constructed for an unimportant local traffic, has still to serve for the dispatch of all through trains; and being situated at a very considerable distance from the centre of the city, in a dirty locality, travellers are wont to remark, that the worst part of their journey lies between the Exchange and St. Rollox. It is matter for congratulation that this arrangement will shortly be improved upon, by the erection of a commodious station in Buchanan Street, not many hundred yards from where we are now writing.

Generally speaking, the Caledonian line is in a very efficient working condition, although, since our journey along it, the bad weather has injured it severely, in carrying off some of its embankments—a fatality common to all newly constructed lines. The rate of travelling upon it, excluding some of the worst gradients, is very fair, the distance from here to Carlisle, 104 miles, being regularly done by the mail train within their stated time of 4 hours 50 minutes, including all stoppages, of which there are a goodly number. The steepness of many of the gradients, in combination with the dampness of the climate, has however a very disagreeable effect in augmenting that intense nuisance of railway travelling—the slipping of the wheels. In our particular case, the morning was thick, dark, and foggy; the rails being in their worst state of partial dryness, and causing a slip to such an extent that an hour and a half elapsed before 22 miles had been gone over. Here there is evidently room for improvement, for although the glaring loss of time and power arising from this slip is daily seen on every railway in the country, nothing has been attempted as a remedy, further than the placing of a clumsy sand box upon the front buffer bar of the engine. In some instances this has been partially improved upon by placing a sort of fixed sand hopper before the driving wheels, with a small curved discharge pipe, and valve to regulate the supply of sand. Throwing on the sand by hand, is most slovenly; and lately, when travelling on a line near this city, we crept along at a minimum of motion for three or four miles, with the fireman walking before the train, actively distributing his handfuls to very little purpose. Sometime since it was proposed to place a species of vertical case over the rim of the driving wheels, for the purpose of holding a block of chalk, the end of which would rest upon the tyre, and give off a film of its substance as the wheel went round. Chalk being a powerful assistant in producing that adhesion of surface termed bite, might probably be made to secure, in this manner, a perfect freedom from slip, without causing any trouble to the driver, or injury to the working portion of the locomotive machinery, to which sand is so destructive. The stations throughout the line are by Mr. Tite, and many of them possess considerable architectural pretensions—that at Carlisle may be instanced as a beautiful example. In many parts, the country traversed exhibits features of the highest grandeur, and the traveller often feels himself impressed with wonder as to how an engine and train of carriages could get so completely embosomed in the hills, no outlet, or accessible pass, being visible. The same remarks apply to a considerable portion of the Lancaster and Carlisle line, where that ancient terror of travellers—the rocky district of Shap Fells—has succumbed to the power of steam.

Further on in the line of communication, the country becomes more English; the landscape is softer, and windmills and brick edifices give unmistakeable note of a change in the manners and customs of the country. In approaching London, beautiful examples of what may be done by mere brickwork, occur at frequent intervals, in the stations and wayside residences. In some instances, an excellent contrast is produced by the window sills and mouldings of light coloured stone, upon the red face of the brick walls; in others the ornamental mouldings, and the general relief works, are entirely produced in clay, with an effect not to be guessed at until seen.

In the line of the Trent valley, the flat swampy nature of the ground forms a disagreeable feature; and for many miles the fields on each side the rails are, at this season, quite engulphed in the overflow from the sluggish low lying rivers.

In London itself, one of the first objects of the attention of the northern resident is the Thames, with its fleets of steamers, and crowded "pool" of ships from all climes. The Thames, a wide sea-like river, almost unassisted by artificial constructions, cannot in any way be likened to the Clyde. The former, being navigable far above the city, is almost as much a highway as Cheapside or Oxford Street, and the inhabitants of the locality take their boat as they would step into an omnibus. The Clyde again, is simply made use of as a channel of communication for far-off districts; hence the bulk of its machinery of conveyance presents an appearance very different to that of its southern cotemporary.

The greater proportion of the small boat traffic is in the hands of powerful companies, as the Citizen, the A. B. C., and the Watermen's. The several fleets of these companies are made up of what, in this quarter, would be termed miniature steam-boats, which are run up and down with a facility and ease of management very striking, as compared with the slow and majestic movements of larger craft. Some of these boats are as remarkable for their speed as for their almost automatic action. Oscillating engines appear to be most in favour, although there are many single beam and steeple engines, the latter class having been introduced by Mr. David Napier, who also led the way in placing similar engines on the Clyde. Indeed, it may be said that this engineer has had much to do with all the varieties of direct-action engines now in use for river purposes; his original ideas having been followed and worked out in all possible forms by most of the modern builders.

In oscillating engines, the Thames engineers, headed by Penn, Miller & Ravenhill, Joyce, and others, have certainly reached an extraordinary degree of perfection, whether as regards precision of performance, beauty of workmanship, or general adaptation to the requirements of the present rates of speed. Originally looked upon as engineering toys, conveying ideas of an elegant mechanical movement, this class of engine has been gradually improved, until the more experienced makers of the present day fear not to adapt the principle to cylinders of the largest diameter. We believe Mr. Penn was the first to demonstrate the practicability of this extension of the system; and we lately saw, in Messrs. Miller & Ravenhill's works at Stepney, several pairs in process of erection, whose dimensions rank with the largest examples of the long established side-lever-engine. Several of these were destined for foreign service; the advantages of the arrangement, whether for war, merchant, or pleasure purposes, having penetrated to the most remote quarters. As an example

of the demand for the last mentioned employment, we may mention that, not long ago, a pair was fitted up in a handsome boat destined for the hunting conveyance of an Indian prince.

In all the small London boats, the engineer's stand is below the deck, and the captain's commands are conveyed to him by a "call-boy," who takes up his position on deck, midway between the two men in power. Putting out of the question the intolerable nuisance of the "long-drawn" cries of the boy, this mode of conveying orders is at once unmechanical, and productive of continued mistakes. Although the boys get into the habit of comprehending every gesture of the commander, and convey his meaning in a remarkably correct manner, yet it is easy to see that the greatest care and watchfulness on his part, will not always prevent the occurrence of serious misunderstandings. In the Clyde boats, the more elevated position of the hand-gear of the engine, admits of the engineer's own attendance to orders, whilst he is not inconveniently placed with reference to his control over the speed and movements of the boat. In the Victoria and Albert royal yacht, a still better arrangement is employed, namely, a telegraphic dial, whose index is in communication with the captain's signalling handle on deck. The graduations of the dial are marked with all the various messages which are in general use, and being placed directly before the engineer below, he can at once read off his orders. We have noticed a contrivance on this principle in some of the steamers running between Glasgow and Dumbarton; here a vertical rod passes up from the engine-room to the gangway between the paddle boxes, and the various messages are signalled by raising and lowering the rod, once, or oftener, according to the order to be conveyed. This plan is certainly inferior to the dial, inasmuch as an error may be easily committed in the movement of the rod. To avoid the loss of time in turning round at the termination of their run, many of the smaller boats are fitted with a bow and rudder at each end, so that instead of making a long round, the rudder last in use, is pinned down amidships, to act as a cut-water, and the opposite one is released to steer by, when the engines are backed. The decks of these boats are simply railed round with a rough stout timber rail, for which, we think, a neat closed panelling might be judiciously substituted, as well for appearance as for protection against the spray. The dress of the men employed in working these boats, contrasts oddly enough with that of the same grade on the Clyde. The heavy fishermen's boots, reaching to their thighs, with their flapped oil-skin caps, although well adapted to keep off the wet, give them a heavy and uncouth appearance.

In its numerous bridges, the Thames possesses rare objects of admiration; the beauty of the curved outline of the arches cannot easily be over-rated. Westminster bridge is in a shaky condition, and has been condemned long ago, although none of the proposed plans have yet been selected for restoring it. Perhaps the most striking of the series is the Hungerford bridge, by Sir I. K. Brunel. In glancing at it, the brick piers convey the idea of extreme lightness, approaching to a want of substantiality; but the noble central span of chains, with its fine convex outline is enough to point it out as a work of great genius.

Having some curiosity on the subject of the Parian cement, we took the opportunity of visiting the extensive works of Messrs. Charles Francis and Sons, at Nine Elms, for the purpose of examining it. This cement is used as a substitute for all kinds of marble, which it imitates most exactly. In a small room at the back of Messrs. Francis' works, and fronting the river, we saw the material applied on the walls as an imitation of every possible kind of ornamental and plain stone work. The most remarkable example of its close imitation was in a panel of factitious fossil marble, where all the varieties of shells, and fossil deposits, were re-produced most accurately, and even the translucency of the crystal was copied in a manner which left nothing to be desired. In the varieties of black and gold, dove, burdilla, and others difficult of imitation, the result was the same, as also in the panel mouldings of white marble. It may be used as a stucco on a brick face, or on laths; as a coating on damp walls, on common plastering, or as polished work of any kind. For a brick face, it is floated on about half an inch thick, with equal parts of sharp sand, and broomed over whilst still soft, but not made too rough. The day after, a setting coat, with one-sixth fine sand, $\frac{3}{16}$th inch in thickness, is laid down with a beech float, and slightly trowelled. If intended to be painted over, the first coat of paint is to be applied about 24 hours afterwards, the paint not having more than one-fifth of turpentine. When applied as a coating on walls where efflorescence makes its appearance, it is mixed with a fourth part of sand, and guaged very stiff, rubbed hard on the face, and broomed before it sets; when set, it is followed up with a floating coat, guaged in the same manner. It is as thus applied for the prevention of damp, that the composition appears to us to possess the strongest claims upon the attention of builders; from its great density and strength, it is most effectual in preserving interiors from this evil.

When used for polished work on walls, the floating coat is mixed with an equal part of sharp sand. The setting coat is a quarter of an inch thick, of fine net cement, rubbed down with grit stones and water, as in polishing marble; the grit to be well washed off the face, which next receives a stopping of fine stiff cement, rubbed in and scraped off with a wooden scraper, until a good face is obtained, when it is finished with snake stone and putty powder. Ornaments for the drawing-room, as inkstands and statuettes, are now being made from this cement: for such purposes, its sharpness and beauty of surface render it highly valuable.

The composition is also applicable for casts, instead of plaster of Paris. For this purpose it is mixed stiff, and brushed into the moulds. Four bushels of the cement powder, costing 18s., when mixed with a like quantity of sand, will stucco ten superficial yards half an inch thick. Mr. Barry has used this material, to a large extent, for the ornamental work of the Houses of Parliament.

Every one who has seen Regent Street, must deplore the untimely fate of the Quadrant Colonnade, the removal of which is now going on, under the direction of Mr. Pennethorne. It is stated that this step arose from the complaints of the owners and occupiers of the shops, that it curtailed their allowance of light, and led to the congregation of bad characters before their windows. There is ground for the former of these complaints, the height of the roof not being sufficient to allow the light to fall properly upon the windows; but, in the latter view, it is rather to be considered as a pleasant lounge for the public. However, it is condemned, and by this time pretty nearly executed, and Regent Street is deprived of its greatest ornament. The older citizens, who remember the locality as it existed previous to Nash's time, will still venerate the princely architect for the work of renovation, in opening up the dense mass of buildings through which he ran "the finest street in Europe," although they will lament that the representations of a few shopkeepers should have ended in the downfall of this monument of his genius.

From a drawing of the Quadrant in its intended altered state, we perceive that the tameness of the house fronts is to be in some degree amended, by an enriched string below what the Londoner terms the "two-pair" windows, and new dressings to the "one-pair;" an ornamental balcony is also to be fitted to each house, in addition to a rearrangement of the front of the mezzanine.

This scheme looks well enough on paper, and if we could forget the Roman-Doric columns, the whole affair would have a good appearance. We observe that at a late sale of the columns (cast-iron), a few brought £7. 10s. each, the original cost having been thirty-five guineas. They weigh about 35 cwt. each. Doubtless they will now be worked up in the erection of railway stations, and other large buildings requiring massive supports. Curious speculations might be indulged in as to their ultimate destination.

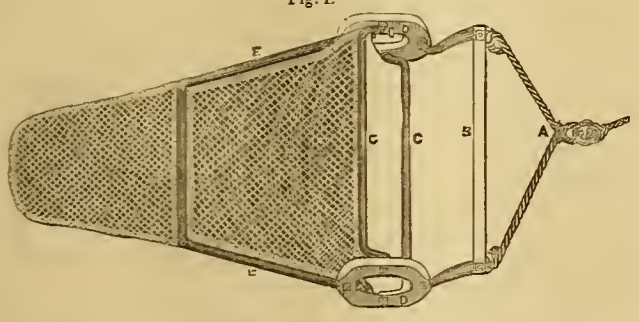
Here we must stop our "Notes" for the present. Next month we may add a few more impressions.

ON THE EXTENSION OF OUR OUTLETS FOR LABOUR—MR. DEMPSTER'S TRAWL-FISHING APPARATUS.

The political economist is continually telling us, that the only remedy for an overhurdened country is an extension of outlets for the exertions of our industrial population. Mr. Dempster of Leith has thoroughly comprehended the nature of the difficulty, and, without furnishing us with columns of statistical figures, he has practised the theory, by furthering the means of a profitable application of labour. In doing this, he has fixed upon a branch of employment which has too truly stood in need of a helping hand; for apathy, prejudice, and, to no small extent, idleness, have conspired to keep it in a position most disgracefully low. We refer to the deep-sea fishery with the trawl-net. By a persevering attention to the minutiæ of this fishery, Mr. Dempster has succeeded in reducing the English system to practice here, and has added important improvements to the old trawl-net, bringing the matter to such a point, that nothing now remains to prevent its actual prosecution, but the unexploded falsities of prejudice. We cannot better explain Mr. Dempster's views than by quoting his own account of his labours in the organization and development of this branch of trade—explaining, in the first place, his proposed modification of the trawling apparatus for deep water, which we lately had the pleasure of examining in Edinburgh.

Fig. I is a perspective view of the apparatus complete, as in the act

Fig. 1.



of trawling. A, Is the span, attached at each end to the extremities of the timber beam, B; C C, are the crank-rods, or stretchers, 10 feet in length, rove through holes in the upper and lower parts of the trawl-heads, D D, and secured with pins or nuts. The trawl-heads are of angle-iron, bent into an oval, 5 feet long, by 2 feet 6 inches deep. E E, Is the net frame of rod-iron, jointed to the trawl-heads; F, the receiving-bag-net.

The crank-rods, C C, work loosely in the eyes of the trawl-heads; and when the net falls, the one that comes upon the ground presses its weight thereon, and adds to the facility of capture. The bag, or receiving-net, is fastened to these rods, and whatever side the apparatus falls upon, the entrance to the bag-net is always open, and the frame, E, prevents the sweeping forward of the apparatus by the current. The span is either of rod-iron or rope.

"A few months since, I wrote a short pamphlet on the subject of trawl-fishing, giving a description of the common trawl-net, how it was worked, and the dangers trawl-nets were subject to, by coming in contact with rocks, stones, or sunken wrecks. I also gave an account of the immense quantity of soles taken yearly on the English coast by this apparatus, and stated that the Brixton trawlers did not hesitate to cast their net in 50, 60, or 70 fathoms water, where they knew soles and turbot located abundantly. As has been my custom since I first commenced to advocate the deep-sea fishing question, I circulated several hundred copies of this pamphlet amongst my friends. A nobleman, to whom I had sent a copy, having read it, sent me a polite note, saying he would be glad if I would favour him with a call, as he was desirous to converse with me on the subject of trawl-fishing. Complying with his lordship's request, during our conversation, his lordship brought forward my statement respecting the Brixton trawlers, and observed it was impossible to cast a trawl-net in 50, 60, or 70 fathoms water, without the danger of its capsizing upside down, bringing the beam on the ground and the bag uppermost, thereby rendering it useless whilst in that position. The only answer I could make to this observation was—'I am aware the trawl-net is liable to the disadvantage of capsizing, from the net being swept forward by the current whilst going down; but the Brixton trawlers, from their skill in casting it, could greatly depend upon its falling fair upon the ground, which it often did.' 'Ay,' remarked his lordship, 'but where are you going to get Brixton trawlers here?' 'Instruct them, my lord,' I answered; 'surely our fishermen are as capable of being instructed as the Brixton fishermen are. Begin with the young, and perseverance overcomes difficulties.' At this his lordship only smiled.

"A few days after my interview with his lordship, my mind became directed towards improving on the old trawl-net. How to overcome the disadvantage of its falling with the beam upon the ground, leaving the bag uppermost, and how to prevent the net from being swept about by the current, are the points I aimed at.

"When I first looked at the subject, I must confess it appeared a somewhat difficult problem to solve; but I soon afterwards found, as I continued to persevere in my research, that I was fast gaining ground by experience, and every minute becoming wiser on the subject. Ultimately, in a very short space of time, the whole difficulty was overcome, and the result of my labours terminated in the new trawl-net. Since completion, my wonder has been how such a simple and useful apparatus was not before discovered.

"The advantages of the new trawling apparatus are—

"*First*—It is handy and portable, easily put together and taken asunder. There is no great skill necessary to work the net. Sailors or landsmen could work the net at sea just as well as trained fishermen. There is no bait or hooks required in this method of fishing, nor is it necessary to handle the fish much whilst taking them out of the net.

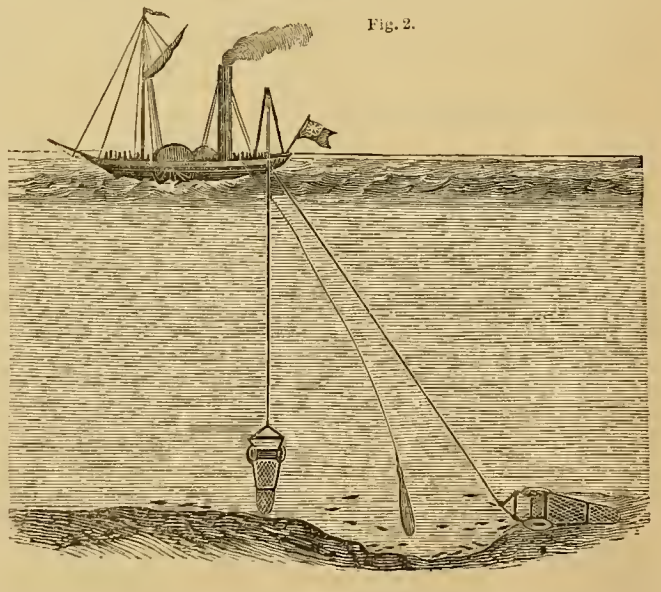
"*Second*—Whatever depths the apparatus is cast overboard, it always falls fair upon the ground for fishing. There is no capsizing of it upside down, a disadvantage to which the old trawl-net is liable. The net is secured from being swept about by the current, so that there is no apprehension of its ever getting foul.

"*Third*—The value of such an apparatus on board of all coasting vessels and foreign-going ships must be very apparent. It often happens that vessels are sailing about, over ground where there are plenty of fish, whilst at the same time the crews of those vessels might not have tasted a bit of fresh provisions for months, or they may have been six upon four for months, or, what is still worse, they may be out of provisions entirely. With such an apparatus on board of ships, sailors could put it together in a few minutes; and as there is always plenty of rope on board, the new apparatus might be cast in hundreds of fathoms if necessary, with as much certainty of its falling fair upon the ground, as if hove in the shallowest places. The saving of salt provisions to owners of vessels might be a matter of importance.

"As very great depths of water have never yet been tried by any trawling apparatus, there can be little doubt that other descriptions of fish, not yet discovered, might be found, if trawled for. The last suggestion may be worth the consideration of those curious in Ichthyology."

Fig. 2 shows three positions of the apparatus as hove from a steamer,

Fig. 2.



and illustrates an idea of Mr. Dempster's for the general improvement of trawl-fishing. At all places where yachting is carried on to any extent, the fishermen of the port invariably use the trawl-net; for yachting and trawl-fishing appear to go hand in hand. The fishermen are led on to the enterprise by the yachters. Here we have one reason why trawling has not been so extensively introduced on these coasts, for the chilly blasts and the uncertainty of the weather have kept yachting excursions behind. Now that steamers have become so common, there appears to

he no reason why they should not be adopted for trawling, as they are in every way suited for it. Mr. Dempster has thrown out the following suggestions on the adaptation of this system in the Frith of Forth:—

"There are eight small steam-boats belonging to Leith for the purpose of towing vessels in and out of the harbour. It is only when the tide suits for vessels being towed in or out, that the tug-boats are very generally employed, and it sometimes happens there is not sufficient employment for all the boats at tide time.

"*First*—Let each of the tug steam-boats be furnished with a trawling apparatus complete, so that at an hour's notice they may be got ready when wanted to proceed to sea on a trawling excursion. The steam-boat proprietors to make known by advertisement, that their boats are furnished with such apparatus, and will be let at so much per day, or for a stated number of hours.

"*Second*—Let the public generally take a deep interest in promoting trawl-fishing, and, when convenient, let parties of friends hire a boat for an excursion. Supposing the boat to be hired for the day, the party could leave the port at say 10 A.M., and be on the fishing ground eastward of Inchkeith at 11 A.M. The trawl-net could then be hove overboard, and dragged at the rate of say 2½ knots per hour. Allowing the net to be dragged for one hour at a time before heaving it up, several casts during the afternoon could be effected. The party would then determine upon what course to pursue—whether to run in to North Berwick, and proceed to town by railway, or return with the boat. As there are always plenty of sea birds floating about the Bass Rock, fowling would be an additional excitement to the excursion.

"*Third*—Whilst trawling, the deep-sea lead, with a bit of grease attached to it, should be hove every few minutes, soundings noted, and remarks made on the chart where the ground is found to be clean for trawling or otherwise. When commencing to heave up the net, the vessel's way should not be entirely stopped until certain of its hanging in a perpendicular position. When the apparatus is hauled close up to the steam-boat's stern, a tackle from the head of the sheers is hooked on to the span, and the net is hoisted up out of the water. The fish are taken out from the lower end of the net by unfastening a lacing.

"The great advantage of party excursions for promoting trawl-fishing, would be, if successful, to discover spots of ground where soles and turbot resort to abundantly; the regular fishermen would be stimulated on to enterprise, and an excellent description of fish would be sent plentifully into market, additionally to other descriptions of fish the markets have hitherto been supplied with."

Mr. Dempster has since published the result of his first day's attempt at trawl-fishing in the Frith of Forth, with the Hero steam-tug as a fishing-boat. On the chart of the Frith, made from the latest surveys, all the middle portion, from Inchkeith towards the Isle of May and Bass Rock, is marked as having a muddy bottom. Some parts appear to be quite level, at others there are deep hollows, such places in fact as soles love to frequent. The intention of the party was to have proceeded below the Inch, to try the middle of the Frith; but the wind being fresh from the eastward, causing a short cross sea, it was determined to direct the boat's course westward towards Inchcolm, opposite Queensferry, to two deep holes in that quarter. Inchkeith being brought to bear E. by S., and Burntisland N. by E., the trawling apparatus was hove overboard in 15 fathoms water, and the boat's head was pointed westward, going at the rate of 2½ knots. By the deep-sea lead, it was found that they were trawling down hill, as at every cast the water deepened. The grease attached to the lead showed that at some points the ground was had, at others, covered with coarse sand and shells. An hour after the net was cast, 30 fathoms was sounded, and the net was then hauled in. On the after-part of the deck, a shears, 25 feet high, was erected, so as to project over the stern; the tackle from the top of the shears was hooked on to the swivel ring of the span, and in this manner the whole was hoisted out of the water. The produce was a few flounders and skates; but, from the bent condition of the rods, it was supposed that the net had at one time been full of fish.

The pockets intended as a trap to retain the fish were not fitted in this trial, as the net was cast to try to bring up fish without them, which may be done if way is kept on the vessel.

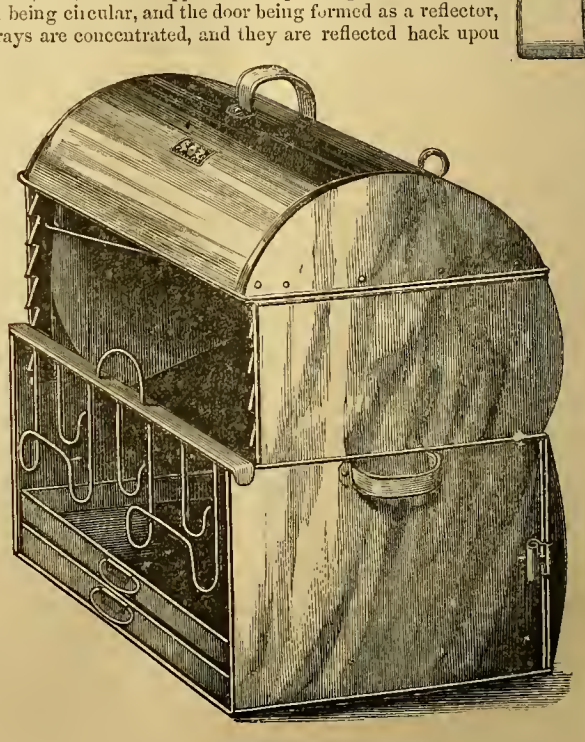
It would be difficult to calculate the vast advantages which may be expected to accrue to Scotland from the introduction of this fishery, so ably advocated by Mr. Dempster. In most of the localities which are suited for fishing grounds, a great proportion of the labouring classes are little removed from sheer idleness; a want of system extensively prevails, and hence lax and irregular habits are contracted. To remove the evils thus occasioned to the general community, no remedy appears to be so well suited as that of systematic employment; and, as far as the fisherman's profession may be said to be free from vicissitudes, the scheme we have described certainly affords the requirement.

IMPROVEMENTS IN DOMESTIC UTENSILS.—RODGERS' TABLE KNIFE WITH IMMOVEABLE BLADE—BUTLER'S COOKING AND ROASTING APPARATUS.

Messrs. Joseph Rodgers and Sons, the eminent cutlers of Sheffield, have registered an important improvement in the table-knife, the full value of which, we are pretty sure, every housekeeper will feel. The loss from the loosening of the blades from their handles amounts to a very inconvenient sum in a large household, and every one knows the unpleasantness of attempting to cut with a knife in this condition. Hitherto the use of cement only, in the attaching of handles to their blades, has led to an almost universal complaint of the occurrence in question, for the mere action of oleaginous matter, not to mention that of hot water, is often sufficient to induce the evil. Our engraving, which is one-third the size of an ordinary table-knife, represents Messrs. Rodgers' improvement, wherein cement is entirely dispensed with, the attachment being effected mechanically.

In addition to the hole for the reception of the tang of the blade, a slight recess is cut out on one side, into which the end of a small spring, riveted or otherwise fastened to the tang, falls, and thus secures the two portions firmly together. When the spring is fastened to the tang, the end of the latter is simply entered into its hole, and the moment the detaining end of the spring clears the notched edge of its recess, it falls in, and, acting like a ratchet detent, no force short of that of fracture of the parts can separate them. The attachment is so secure that no one but a thorough table-knife cutler can remove the handle; but as the blade generally lasts as long as its handle, we suppose the removal will be seldom necessary.

The figure below, is a perspective view of a cooking apparatus on the radiating principle, by Mr. Spilsbury Butler of Birmingham. The top of the apparatus, or oven, as it may be termed, may be elevated on the front side by a catch fitting into a rack, formed on each side. A ring at the back enables the user to adjust this; and, by the same means, the joint or other articles undergoing the cooking process, may be moved nearer to or farther from the fire. On each side are wings, forming double sides, so that when the top is elevated, the air is prevented from passing through. The gallery in front is moveable, and may be occasionally used for cooking steaks, &c. The bottom sliding pan is intended for baking potatoes, &c., and the upper one for puddings. The top and back being circular, and the door being formed as a reflector, the rays are concentrated, and they are reflected back upon



the articles to be cooked. The oven may also be used to bake bread, and to perform the regular services of an ordinary oven.

Amongst a multitude of other schemes, the two we here present are fair evidence that, in the midst of the great mass of the higher range of scientific improvement, the culinary department is not entirely overlooked. Invention progresses even in the kitchen—mechanism advances its all-powerful aid to the engineer and the butler indiscriminately, and, in the cases we monthly bring forward, not unworthily in either grade of pursuit.

ATMOS THE GIANT, THE SON OF PYROS AND HYDOR.

A QUAINT STORY OF STEAM.

A short legendary history of the steam-engine that appeared in the *Penny Mechanic* (an almost forgotten periodical), at the time we commenced the study of mechanics, made so lasting an impression on our minds, that for the amusement of older readers, and we hope also for the instruction of the younger branches of the community, we will endeavour to relate the most wonderful history of the giant Atmos; premising that Atmos is the Greek word for *steam* or *vapour*, and that the errors and omissions of the ancient chronicle have been carefully avoided, whilst many material circumstances, as well as much curious matter, have been collected from the best authorities.

The genealogy of the race of Atmos stretches back to the remotest antiquity—in fact, its origin dates with creation itself. At the very commencement of their labours, the important charge of nourishing the whole of the antediluvian vegetable kingdom, was intrusted to the care of the mighty ancestors of "the children of the mist." These looming giants, although continually aiding the fructifying influence of the sun, always fled from his presence, and laboured at their grateful tasks, only amidst clouds and darkness, or under shelter of "the mist that went up from the earth."

The marked peculiarities of the race remain unchanged to this day. Whenever Tubal Cain (the father of all workers in metal) quenched his heated implements of art, he disturbed a slumbering giant, who, then as now, started off into the air with a sharp *hiss* of apparent ill temper.

Without regarding the many dubious traditions of this busy race before the flood, we find them, immediately after that event, prominently engaged in upholding that enormous and magnificent fairy bridge, the gorgeous "arc in heaven" of our French neighbours, or the "rainbow" of our plodding selves.

Atmos, however, rendered but little obedience to the commands of mankind, and, indeed, was hardly known to them, until the world outgrew its infancy; and then a few of the powers of the giant (*our* giant we may now call him) were revealed in dreams to the wise men of old.

In these first visions and apparitions to the magicians, Atmos prudently confined his revelations to the most simple of his capabilities. And although men were at that time well acquainted with the wonderful powers ascribed to the necromantic tribe of genii, and all the other "faery sprites," yet the newly-developed strength of the young giant was so astounding, that not only was its superiority questioned, but many so-called philosophers, boldly denied the fact of his existence!

But at length a mighty magician, deeply versed in fairy lore, put Atmos to the trial. A chamber, built in the form of a sphere, was hung upon pivots, and from it proceeded two rather long passages, each having a door on one side.* When matters were thus prepared, in trembling agitation, and amidst the scoffs and jeers of the ignorant, the magician invoked the sprite, and, by the potent aid of fierce fiery spells, caused him to enter the chamber. At first, Atmos merely amused himself by puffing out light curling clouds, but soon scorning the constraint of his dark and heated quarters, forth he sprung, leaping with such headlong eagerness, that the mere force of jumping from the door, set the chamber spinning round, as if it would have torn itself to pieces. But the giant was so well disposed to submit to the rule of his masters, that he continually reappeared in the chamber and repeated his precipitous leap, till the machine became surrounded with whirling masses of dense white clouds, and not only shrieked and groaned in the agony of its forced movements, but sometimes threatened to burst its bonds, and free itself from the torture of the spell. In this manner, Atmos was compelled to assist in the worship of the Athenian gods, at least two thousand years ago; and the same incantation has been found to be so well suited to some of his peculiarities, that it is generally employed at the present time, whenever he is required to appear in this character. An instance of the success of the spell was recently chronicled in our pages, namely, Nasmyth's saw for the use of the iron road.

A few years ago, poor Atmos was subjected to much ill treatment by a magician,* widely celebrated for his romantic dealings with the spirits of the air. The queen of the *(industrious)* fairies having, of her own "gracious pleasure and mere motion," given the magician power to exercise his cruel will, for his especial benefit, for the full term of fourteen years, the giant could only submit; but he amply avenged himself on the philosopher by most unceremoniously thwarting his favourite schemes on every possible occasion. The new enchantment was effected by placing a moveable screen in front of the door by which Atmos made his escape: in his blind haste to be free, he heeded not the obstruction, but, rushing headlong upon it, the shock of his bulky carcase set it in motion, just as the magician expected. And it is characteristic of Atmos' natural simplicity of temper, that experience appeared to be thrown away upon him; for as frequently as the screen was replaced, he plunged head first upon it.

Atmos appeared next as a pounder of drugs. A magician actually made him blow a wheel round by his breath!† and it was a most singular circumstance that the better his father was fed, so much the better did Atmos perform his task. The old gentleman had certainly a rather strong digestion, and a most voracious appetite; few things came amiss to him, and he had a remarkable relish for a few dry shavings, or a slice of turf. It was almost frightful to witness the state of excitement into which Atmos was thrown when his father's appetite met with a little extra indulgence; his strength increased almost beyond restraint, and he whistled, nay screamed, with delight, and sometimes actually boiled over with frenzy.

The spread of knowledge led, however, to an improved method of ruling the giant, by means of his natural affections; and instead of increasing his restraint when he fell into one of his boisterous fits, and threatened mischief, a simple mode of giving vent to his ill temper was adopted, and he was then more under control than ever.

The whole family of Atmos—father, mother, and his big brother, to whom we shall shortly have to allude more particularly—were all impressed into the service of mankind, both jointly and individually, and rendered important service to the maintenance of animal life, and the progress of civilization. The mother of Atmos was in constant demand, but being of a naturally retiring disposition, always endeavouring to occupy the lowest and humblest situations, never of her own accord mounting any ascent however easy it might be made, she often lay hid, like Truth, at the bottom of a well. A suitable room for her reception was prepared, with a passage leading to the place she had selected for her abode; Atmos was then introduced into the room, and being left to himself, gave way to his natural inclinations, and gradually lifted the old lady into his comfortable apartment, where she was ready to discharge any task on which the magicians wished to employ her.‡ Atmos continuing to reveal his enormous powers to the magicians, promised to perform almost any task they pleased, if they would only study his own and his relatives' tempers. On these conditions he offered to lift the heaviest weights as easily as he would work the most delicate fibres; he would carry them and their goods with a speed that should outstrip the wind; he would defy the waves and tides, and would navigate their ships in defiance of the elements. He even hinted that he could help them in the air, and that they might fly on his back like swallows in a summer's day.

On more than one occasion this confidence of Atmos brought the possessor of the secret into trouble. His neighbour thought the magician was mad, and instead of profiting by the offers of the giant, actually put his masters into prison.§ But the reiterated promises of the giant at length gained partial credence. A tall cylindrical tower was built, with a floor artfully made to slide up and down, so that a chamber might be made of any dimensions to suit the ideas of Atmos, who was conducted into it. His aspiring nature soon caused him to take up the greatest possible space. When he had thus raised the floor to the top of the tower, his mother was introduced. She, poor body! was always troubled with a cold, and as Atmos delighted in warmth, the knowledge of her presence at all times cast a chill upon his schemes; his natural affections also brought him down to a level with his aged mother; but no sooner had he left the tower, than his big brother, Atmos-*phere*,‖ with his usual antagonism, endeavoured to occupy the vacated space, but finding no entrance, was obliged to content himself with forcing down the floor to the very bottom of the tower. This quickly aroused Atmos, who speedily raised the floor to its former elevation, in spite of his brother's strenuous opposition; and thus, at each repetition of this romantic scene, the floor was moved up or down by one brother or the other.¶

* Hero's engine, or æolipile.

* Pilbrow. Patent dated 23d May, 1842. † Branca's engine.
‡ Marquis of Worcester's, Savery's, &c., engine. § Solomon de Caus.
‖ Atmos *phere* or *fear*, probably so called from the opposition he always shows to the movements of Atmos, who never fails, when fairly roused, to drive his brother before him.
¶ Newcomen's engine.

The motion thus obtained, as might have been expected, from family feuds, gave rather uncertain results, although they surpassed all that necromancy had ever accomplished before.

It remained for one of our own countrymen,‡ the most celebrated magician the world ever saw, to employ Atmos alone, without permitting his brother to interfere. The tower was therefore roofed in, and when the moveable floor was raised, Atmos himself was employed to thrust it down again. He did this with the most perfect ease and good temper, knocking it playfully backwards and forwards like a kitten with a ball of thread, never tiring or showing the least symptoms of impatience so long as he was treated with proper respect. He now works under this spell more busily than ever. He has lately learned to outstrip our fleetest coursers. Like them he snorts impatiently at starting; but no sooner does he feel the excitement of the race, than his thickened breathing becomes one continuous purr of pleasure, and he rushes along with a most determined purpose of progression, until he feels his master's constraining hand—at a touch he slackens his pace, and stands still like a child.

Atmos has had his biographers, his friends, and his foes. He has had his disciples and his masters, and, like the mighty gods of old, his priests and prophets also. We close our grateful exercise in his service with a partly fulfilled prophecy; and never let his admirers say in despair, that all that is possible has been already accomplished. The sprite is good, please him by studying the depths of his beautiful nature, and then most surely will he give his rich rewards.

"Soon shall thine arm, unconquered sprite! afar
Urge the slow barge, impel the rapid car;
And, on thy wings expanded, bear
The flying chariot through the realms of air."—*Darwin.*

D.

ANATOMY OF THE PHYSICAL STRUCTURE OF THE UNIVERSE.

By Mr. R. Smith, Blackford.

VII.—Light.

Dr. Schafhaeutl, well known by his researches on the subject of iron and steel, has paid some attention to the employment of light as a delineator, and, in 1840, he read a description of his experiments before the British Association, at their meeting in this city. By his plan, a copper plate is covered with a thin layer of hyrdruret of carbon, prepared by dissolving pitch in alcohol. The coating is applied to the plate whilst the latter is in a heated state; it is afterwards carbonized in a close iron box, and, when cold, is passed between a pair of steel rollers. In this state it is dipped in a saturated solution of nitrate of silver, and is instantly placed in the camera. A copper plate so prepared is so extremely sensitive, that the reduction of the silver actually commences before the feeble light of a solitary candle. When the image has been taken, it is fixed by dipping the plate into alcohol, in which a small quantity of hyposulphate of soda has been dissolved.

Mr. R. Hunt, whose name is brilliantly associated with almost every improvement in photogenic art, read an account of another process before the British Association in 1841. Glazed letter-paper is washed with a solution of one drachm of nitrate of silver in an ounce of distilled water; it is then dried and washed a second time, and again dried, and placed in a solution of one drachm of hydroiodate of potass dissolved in six ounces of water. It remains for one minute in this solution, and is then washed in water, and dried in the dark. To render this paper sensitive, it is wet with a solution of ferro-cyanate of potash, containing a drachm of the salt to an ounce of water. The drawings are fixed by washing them with the hydroiodic solution. The Astrotype, mentioned at the conclusion of our last month's chapter, was invented by the author in 1841, and an account of it was read before the Royal Scottish Society of Arts in 1843. The report of the committee examining the invention states, that "the mode adopted by Mr. Smith for taking photographic images of the heavenly bodies is simple and ingenious; however, as M. Daguerre obtained images of the sun and moon at an early period of his researches, Mr. Smith's attempt can scarcely be considered as new."

The instrument which M. Daguerre employed for taking a delineation of the moon was simply the ordinary photographic camera. The author's apparatus for producing representations of eclipses of the heavenly bodies, consists of a square box, with a tube 3 feet long and 4 inches in diameter attached to it. The external end of this tube carries a convex lens 4 inches in diameter, and 3 feet 6 inches focal distance. When the instrument is properly pointed, the screen is removed, and the image falls upon a sheet of sensitive paper inside the box. Any of the common kinds of photographic papers will answer the purpose of taking the eclipse of the sun; but for a lunar eclipse, the calotype paper is requisite. When impressions thus obtained are examined by a microscope of a large field of view, and magnifying from 500 to 700 times, the spots upon the sun's disk, or the inequalities upon the lunar surface, are exhibited very beautifully. This process differs materially from that of M. Daguerre, who never applied it for taking eclipses.

Upon this point, Mr. Talbot, the eminent photographist, has observed, "I have certainly heard it suggested that photographic impressions of the sun might be taken during an eclipse, but am not aware that any person has actually done so."

Specimens of impressions of an eclipse of the sun, which occurred on the 18th of July, 1841, and of another of the 8th of July, 1842, were exhibited before the Royal Scottish Society; the former ones are spoken of by Sir D. Brewster as being exceedingly beautiful and well-defined.

Some time previous to 1844, the author, being engaged in a series of experiments on natural and chemically prepared compounds, with a view to the ascertaining of which was the best for photographic purposes when in combination with the salts of silver, discovered that urine produced excellent effects. This process he has termed Uritype, and a paper upon the subject was read before the Royal Scottish Society of Arts in 1844. Glazed letter-paper is first washed on one side with the fluid in a fresh state, and is then dried. It is then washed over with a solution of nitrate of silver, of 100 grains of the salt to an ounce of water, and dried in the dark. After receiving the image in the camera for a few seconds, the paper is taken out, and is dipped first in water and afterwards in a solution of one drachm of sulphate of iron to a pint of water. The sheet is pushed to and fro through this solution until the impression is fully developed, when it is washed in water, and fixed by placing it in a solution of hyposulphate of soda, as in the calotypic process. The picture obtained in this manner is a negative one, and a positive delineation is produced from it in the usual manner, by placing it over another sheet of prepared paper, with a sheet of glass pressing the two into close contact, whilst submitted to the action of light. This paper is easily prepared, and is free from spots or defects of any kind.

Sir John Herschel has the credit of the discovery of the Chrysotype, in 1843. The paper is prepared by washing in a solution of citrate of iron and ammonia: 100 grains of citrate of iron are dissolved in 900 grains of water; liquid ammonia is then added to the solution until a precipitate is formed, and the ammonia is further added, drop by drop, until this precipitate is dissolved. Paper washed on one side with this solution gives a faint yellowish picture; to add to it full force and vivacity, it is washed with a solution of chlorate of gold, neutralized by soda.

The Cyanotype, or Ferrotype, is another process by the same discoverer. The paper is prepared in the chrysotypic manner; but in bringing out the image, a solution of ferro-cyanate of potash is used instead of the gold solution, and a violet-tinted picture results.

In 1844, Mr. Hunt produced his discovery of the Energiatype. The paper is washed with the following solution:—A saturated solution of succinic acid, 2 drachms; mucilage of gum-arabic, 1 drachm; water 1½ drachms. When the paper is dry, it is again washed with an argentine solution, consisting of one drachm of crystallized nitrate of silver in an ounce of distilled water. It is then allowed to dry in a dark place, where it is kept for use. From two to eight minutes is the time for exposure in the camera, varying according to the relative brightness of the day. The impression is brought out by quickly brushing over with a wide flat brush, a mixture of one drachm of a saturated solution of sulphate of iron, with two drachms of the mucilage of gum-arabic. As soon as the image is completely developed, the iron solution is washed off with a soft sponge and water. The sheet is afterwards soaked in water for a short time, and the delineation is permanently fixed by washing with a solution of hyposulphate of soda, and then in water. From this negative picture, any number of copies may be obtained by operating with the succinated papers, as in the calotypic and uritypic processes.

The Catalysotype was discovered by Dr. Woods, and a paper descriptive of the process was read at the York meeting of the British Association; and more recently an improved detail of it was published in the proceedings of the Royal Irish Academy. Two drachms of the syrup of ioduret of iron are mixed with an equal quantity of distilled water, and to this is added twelve drops of tincture of iodine. The paper is first brushed over with this solution, and dried between sheets of blotting-paper. It is afterwards washed with a solution of nitrate of silver, one drachm of the salt to an ounce of distilled water; and when so prepared, is quickly placed in the camera. The image is fixed by first washing in water, and then placing it in a solution of hydriodate of potassa, five grains of the salt to an ounce of water—again washed in water, and dried.

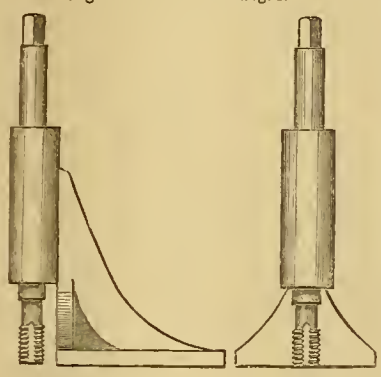
* James Watt.

WORKSHOP ECONOMICS.—NASMYTH'S TAP-GUIDE AND SWAGE-BLOCK.

Few engineers have rendered so much service in the improvement of constructive machinery as Mr. Nasmyth, whose contrivances for economizers of labour are all impressed with that true mark of genius—aptitude of purpose. The simple implements above-named may worthily take a place in our chapters on "Workshop Economics," for they have acted a notable part, as well in saving time as in perfecting our processes of conversion of materials.

It would appear to be an easy matter to put a good screw-thread in a truly drilled hole, with an efficient tap; but a practised eye will detect many instances in modern machinery, where this operation has been sufficiently ill performed to warrant us in saying, that "a practical difficulty" is in the way even there. The difficulty in question is the tendency of short taps to get off the perpendicular in entering their hole, and thus, when the screw is brought home, its head bears more on one side than on the other, producing what a clever mechanic always deems a great eye-sore. Mr. Nasmyth's contrivance for the avoidance of this evil is figured in our accompanying cuts. Fig. 1 is a front, and fig. 2 a corresponding side elevation of the guide, with a tap as adjusted in the act of tapping a hole. It is nothing more than a small bracket, whose bottom surface is set at a correct right angle with a vertical guiding tube cast upon it. The tubular guide is adjusted over the centre of the hole to be tapped, its bracket being clamped or bolted down to the surface of the work. The tap has a long shank, turned to fit the guide tube, into which it is passed, and is so retained in a correct line with the axis of the hole. By forming the tube at an angle with the foot of the bracket, holes may be accurately tapped at any such angle as may be desired.

Fig 2. Fig. 1.



Figs. 3 and 4 exhibit Mr. Nasmyth's V, or compound-faced swage-block, contrasted with the old form of block. Fig. 3 shows the result of the compression of the metal between two surfaces only. The action of the two surfaces, which may be considered as nearly parallel, tends to displace the concentric laminæ of the round bar, forming a straight line across the centre, producing a fundamental unsonndness, as the bar will nearly always crack and give way at one or other of the rectilineal laminæ thus occasioned. When the same bar is compressed in the V swage-block, fig. 4, this flat lamination is entirely prevented, being, in effect, the same as if struck at three places at once, every blow, or portion of the compressing action, being directed to the axial line of the bar; and in this way each force is counteracted by its neighbour, and a regular condensation of the molecules takes place in the centre of the mass. Where two surfaces only are in operation, the metal is forced outwards at right angles to their line of action, and the main object of the rounding process is thus partially frustrated.

Fig 3.

Fig. 4

Sections of actual forgings have borne out the truth of the theoretic action of the V swage, and the improvement has been extensively introduced by the inventor into the Government dock-yards, where its advantages, in forging anchor shanks and other large work, are duly appreciated.

ACOUSTICS.

It is the object of acoustics to determine the laws of sound, and the phenomena connected therewith. The name of this branch of physics is derived from a Greek verb, signifying *to hear*.

Philosophers are not agreed as to the definition of the term *sound*. With the greater part, it is the sensation arising from a vibratory motion of sufficient rapidity, impressed upon an elastic substance. Others define it as a particular motion excited in ponderable matter, calculated to affect the organs of hearing. In general, sound has been described, rather than defined, and perhaps it is difficult to do otherwise. For want of a convenient definition, we shall restrict ourselves to a statement of facts. Sound is a phenomenon which, by means of the organ of hearing, places us in a certain relation with bodies from which we are more or less distant.

A healthy and well-formed ear experiences a peculiar sensation every time that an elastic body, placed in its vicinity, vibrates with rapidity. A bell of metal or glass, a distended string, a slender bar of steel, are instances of such elastic bodies, the vibrations of which are visible to the eye when struck. Those of metal and glass bells are perhaps less perceptible; but they exist, notwithstanding, as a simple experiment will show. Suspend in a large glass bell a small metal ball, attached to a slender thread, and after striking the bell lightly, incline it so that the ball may touch one side of it. The ball may then be seen to leap off repeatedly from the side, being repelled by the vibratory motion of the glass; and its repeated falls, in consequence of its weight, may be heard as well as seen. In some cases, indeed, (wind instruments for example,) one might be disposed to doubt the existence of a vibratory motion, which, to the present time, has been regarded as the origin of the impressions which have their seat in the organ of hearing. But it is easy to prove that it is the air which performs the functions of a sonorous body, and is subjected to vibrations like more solid matter.

The presence of a body actually in vibration, is then an indispensable condition for the production of sound; but it is not the only one. If we place under the receiver of an air-pump, a small bell, so that we have the means of ringing it when in that situation, we shall hear it ring as long as the receiver contains air. But after exhausting the air, no sound will be conveyed to the ear. Allowing the air to re-enter gradually, sound will be again audible, and it will become louder in proportion to the quantity of air admitted. It is evident, then, that in addition to the body calculated to produce sound, there must be an appropriate medium by way of vehicle. The air usually acts as this vehicle, but any other elastic body may take its place. A person whose head is under water, will distinctly hear the shock of two stones in the same liquid. If the ear is pressed closely against one end of a long beam, the scratch of a nail at the other end will be transmitted along the wood with perfect distinctness. In what does the mode of transmission consist? In solids, we may compare it to what takes place when a number of billiard balls are put in a line, and a blow is struck at the first one: the motion is communicated to the second, from that to the third, and so on until it arrives at the last. Only it is to be remarked, that the internal structure of bodies, the arrangement more or less regular, and the homogeneity more or less perfect of their molecules, modify this propagation. The intensity of sound increases or diminishes with the density of the medium transmitting it. Saussure tells us that, at the summit of Mount Blanc, an exploding pistol made no more noise than the crack of a whip on the plain. At the height of 22,800 feet, the highest point which man has reached, Guy Lussac, on his celebrated aerostatic ascent, found that the strength of his voice was very much weakened. For the same reason, condensed air, and a dense gas, render the influence of sound more forcible on the ear. It is by speaking in atmospheres of more or less rarefaction, that ventriloquists are able to effect some of their curious illusions. In air or water it is propagated in all directions, so that we may regard the sonorous body as the centre of a sphere, whence undulations are sent off on all sides similarly to the waves on the surface of a sheet of water, which a stone thrown into it will create. The agitated medium augmenting in size, as it recedes from the origin of the motion, we may conceive that the sound will gradually grow weaker, and will end by becoming inaudible. This is just what experience tells us is actually the case. According to the nature of the medium this effect is manifested after a time more or less long, and when the space affected is more or less considerable. In general, under similar conditions, the intensity of a sound is in inverse ratio to the square of the distance.

We distinguish between the intensity, the tone, and the quality of sounds. The first has reference to the extent of the vibratory movements—in other words, the loudness of a sound; the *tone* depends on the number of vibrations in a given time, and this determines its height or lowness in a musical sense. We are not accurately acquainted with the circumstances that occasion the differences in the *quality* of sounds; for instance, the difference between the sounds of the flute and the clarionet, or the bassoon and the horn.

The speed with which sound travels through the air varies with the temperature, but all sound of every kind is propagated with the same rapidity in the same medium. When the air is at 60°, sound travels through it at the rate of 1105 feet per second; at 50°, 1094 feet per second; and at 32°, 1075 feet per second. This speed is unaffected by the barometric pressure, and is the same for sounds of different intensities and qualities. Thus, in the higher regions of the atmosphere, loud and

feeble sounds, grave and acute ones, are disseminated with the same rapidity as at the surface of the earth. Theory and experiment may both be resorted to for a determination of the speed of sounds. If the latter is well conducted, incontestable results are obtained without troubling ourselves to ascertain all the producing causes; but as to theory, unless we are in possession of all the elements, we shall fail in attaining accuracy. Thus, for some time, the speed of sound through common air was theoretically calculated to be 907 feet per second, whilst experiment gave about 1087 feet. This difference, much too considerable to be attributed to the mistakes of the experimenters, indicated the existence of some unknown condition which theory had not taken into calculation. Laplace thought that the successive condensations and dilatations which occasion the sonorous waves, produce a disengagement of heat, from which ensues an increase in the elastic force of the air, and, consequently, in the speed of the transmitted sound. In correcting from these data the formula relative to the transmission of sound, theory and experiment perfectly agree in the results obtained, not only with respect to atmospheric air, but also to many gases; for in these media the rapidity of motion is, as we have said, inversely proportional to the square root of their density. In atmospheric air, the density of which is assumed to be unity, sound at a given temperature travels at the rate of 1081 feet per second. In hydrogen gas, the density of which is ·0688, it must travel at the rate of 4125 feet per second; for, according to the law just stated, we have—

$$1081 : X :: \sqrt{.0688} : \sqrt{1},$$

a result confirmed by experiment.

Amongst the experimental methods for measuring the rapidity of sound, the simplest, and the one most frequently employed, consists in selecting two stations whose rectilinear distance is considerable, and accurately measured. The observer placed at the one must have a clear view of the observer at the other, so as to learn the precise moment when the explosion takes place, of which the sound is about to be measured in its rapidity. Counting the number of seconds elapsing between the flash and the sound reaching the ear, the observer possesses the two elements (space traversed, and time occupied) which enable him to ascertain the speed. In 1822, certain experiments were instituted by order of the French government, in which a cannon was discharged at each station, producing an explosion, and giving at the same time a signal. In these experiments, the mean of twelve consecutive observations, in a temperature of 60°, gave the result above mentioned.

When the undulations of sound meet with an obstacle they are reflected, making the angle of reflexion equal to the angle of incidence, in the same manner as with reflected light, but they continue to move with the same speed as before. Changes of direction thus brought about, frequently produce irregular echoes, depending upon local circumstances, which are often difficult to explain. Some echoes, for instance, repeat several times the same syllable or the same word. The speaking-trumpet used on board ships, and on other occasions, is constructed with reference to the reflexion of sound.

We will now devote a few words to the motions and sounds of tightened chords, strings, or wires, when removed from their state of quiescence by sudden percussion. The number of vibrations made between the two extremities, which we must suppose firmly fastened down, are in inverse ratios to their lengths, but proportionate to the square roots of the forces which stretch them. For chords of the same substance throughout, the vibrations are in inverse ratio to their diameters, and for chords of different materials, they are in inverse ratio to the square roots of the densities. With the sonometer or monochord, we find that the lengths of the chords which yield the sounds of the major gamut, *do*, *re*, *mi*, *fa*, *sol*, *la*, *si*, *do*, are represented respectively by the numbers, 1, $\frac{8}{9}$, $\frac{4}{5}$, $\frac{3}{4}$, $\frac{2}{3}$, $\frac{3}{5}$, $\frac{8}{15}$, $\frac{1}{2}$, so that the number of the vibrations corresponding to the same notes can be represented by the numbers, 1, $\frac{8}{9}$, $\frac{5}{4}$, $\frac{4}{3}$, $\frac{3}{2}$, $\frac{5}{3}$, $\frac{15}{8}$, 2. These numbers, and those of the minor gamut also, are in what mathematicians term harmonical progression, and that progression takes the form of 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, &c. For the relationship of the two first terms of the progression gives 2, or the octave; of the second and third, $\frac{3}{2}$, or the fifth; of the third and fourth, $\frac{4}{3}$, or the fourth; of the fourth and fifth, $\frac{5}{4}$, or the major third; of the fifth and sixth, $\frac{6}{5}$, or the minor third; of the eighth and ninth, $\frac{9}{8}$, or the major tone; of the ninth and tenth, $\frac{10}{9}$, or the minor tone.

It is very important to observe that all the harmonical sounds exist simultaneously in the vibrations of a single chord. A practised ear detects, beside the fundamental sound yielded by a violin string vibrating at the touch of a bow, the sounds 2 and 4 (octave and double octave), the sound 3, or the octave of the fifth, and the sound 5, or the double octave of the third; some persons add even the sounds 6 and 7.

The musical intervals between two notes are in general more agreeable in proportion as the relations of the numbers of the corresponding vibrations are simple. The perfect chord is formed by three notes, of which the intervals of the first, second, and third are, respectively, a major third and a major fifth. There are, therefore, in the gamut three perfect chords, viz:—1st, *do*, *mi*, *sol;* 2d, *sol*, *si*, *re* (octave); 3d, *fa*, *la*, *do* (octave).

We may begin the gamut by any note whatever, provided that we alter certain intervals, so as to render them equal to the values we have given above, or at least to within an 81st part. For it has been remarked, that when an interval is equal to 80-81 of another, the ear will readily tolerate the substitution of one for the other. We shall therefore have more or fewer notes to alter, in order to fulfil this condition. If we begin with *sol*, we perceive that the relation between the six notes *sol*, *la*, *si*, *do*, *re*, *mi*, are identical (within 1-81) with those of the six notes *do*, *re*, *mi*, *fa*, *sol*, *la*. But in order that the relation of *mi-fa fa-sol* may be made equal to those of *la-si si-do*, it is necessary that *fa* should be raised or made sharp. The key of the major *sol* only differs, then, from the key of the major *do* by the elevation given to *fa*. We may pass in like manner from the key of *sol* to the key of *re*, by sharpening *do*, and this will give two sharps to the *cleff* in written music for the key of *re* major. The key of *la* major will have three sharps, and so on. But if, in this last gamut, we take *fa* and *do* without sharps, a peculiar impression, with regard to melody, is obtained—sad and melancholy—belonging to a new gamut, to which the term minor is applied. We have thus passed from the major to the minor key, by lowering or adding a flat to the sharp *fa* and the sharp *do*; in other words, by taking away their sharps, and restoring them to the original state. And so we pass from the key of *do* major to that of *do* minor, by adding flats to *mi* and *la*, without meddling with the other notes. It is a little remarkable, that the native airs of almost all countries, and especially those of northern climes, are in the minor key.

The term 'wave of sound' is given to the curve which represents the series of all the movements of contraction and dilatation, to which all the particles of a sonorous body are subjected during an entire oscillation of the surface in vibration. Mathematicians call this curve a *sinusoid*: it is composed of a contracting wave and a dilating wave equal to each other. We obtain its total length by multiplying the speed of the sound, in the substance under consideration, by the duration of a complete vibration corresponding to the tone producing it.

In a prismatic or cylindrical pipe, when the air is subjected to sonorous vibrations, there will be a nodal section, that is, a motionless section, at the closed end; whilst at the open end there will be a section experiencing the greatest displacements in the vibratory motion. Pipes which are open at both ends, can, for this reason, only produce the sounds represented by the numbers 1, 2, 3, 4, &c.; and pipes closed at one end give out the succession of sounds 1, 3, 5, 7, &c. The existence of nodal *surfaces* is manifested in various ways by the formal arrangement of light bodies, such as dust placed upon those surfaces. Thus, if we spread upon a piece of glass any light powder, and throw the glass into vibrations by drawing a violin bow across its edge, the powder will be seen to arrange itself in formal lines and figures of singular variety.

The law of longitudinal vibrations in elongated bodies, combined with the use of the monochord, served at first to determine the absolute number of vibrations which correspond to a given sound. Other means have since been invented; and it seems to result, that the human ear can perceive sounds of which the vibrations vary from 15 to 48,000 per second. The voice of a male person usually extends over two octaves—*sol* to *sol;* and the numbers of the corresponding vibrations are respectively 396 and 1584. The female voice mounts from *re* to the octave of *do*, the vibrations being respectively 594 and 2112.

IRON MARKET-HOUSE AT SAN FERNANDO, TRINIDAD.

Illustrated by Plates 21 *and* 22.

We this month add a transverse sectional elevation and details, to the longitudinal elevation of Porter's Market-House. The two views are sufficiently clear to afford their own general explanation, and little more is required, after a description of the enlarged details in Plate 22.

Fig. 1 is a portion of a longitudinal section of the ridging forming the apex of the roof, with the ring-bolt omitted. This figure shows the amount of corrugation of the metal, which Mr. Porter considers to be best suited for strength and economy. Fig. 2 is a transverse section of the same part, exhibiting the method adopted for securing the corrugated covering to the angle-iron purlins, and also the attachment of the purlins to the wrought-iron rafters.

Fig. 3 is a transverse section through the girder, connecting the main stanchions—with the attachment of the panelling, trellis-work, and roof. The trellis-work is formed simply of two wrought-iron bars, crossing each other, and riveted together at their central junction, and to the top and bottom angle-iron, which binds the whole together. It is very

light, having to carry only its own weight over a seven feet bearing; the roof being snpported by the projecting brackets of the stanchions.

Fig. 4 is a vertical section of the pilaster stanchions and pedestal bases, with the wronght-iron standing covering; and fig. 5 is a horizontal section of the pedestal base of the stanchions. These bases are bolted to a stone foundation, by four stout joggle bolts, a packing or washer of lead being interposed between the metal and stone surfaces.

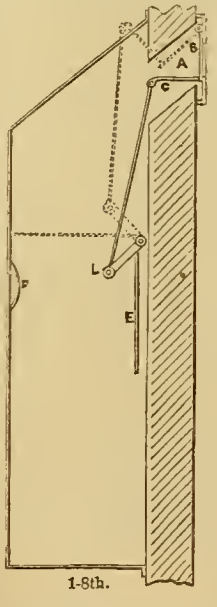
In several parts of the building, where a firm and uniform bearing is desirable, a packing of the patent tarred felt is introduced between the snrfaces of the iron-work; and in those parts where the buildiug is likely to be much affected by the alternate expansion and contraction of the metal, the bolt holes are slotted to permit of a certain amount of motion of the parts over their bolts.

For particnlar purposes, the metal plates for roofing may be serrated, or bent into an angular, instead of a wavy or curved section, but the latter is generally preferred for its greater stiffness and beauty of appearance. Whatever section may be employed, the gain in point of lateral strength is immense. A thin sheet of plain metal, which, when laid across two supports, will bend considerably with its own weight, will, when corrugated, actually support a very considerable load witbout any perceptible deflection.

For large spans, the corrugated principle appears to be peculiarly applicable, as the extreme of lightness is obtained by it, and no other covering hitherto known will bear comparison with it in sustaining power.

MESSRS. BRYDEN'S SAFETY RECEIVING-BOX FOR LETTERS AND PARCELS.

The abstraction of letters from the receiving-boxes of the Post Office, as well as from private offices, has always been a favonrite pursuit with the members of a certain class, who have been jocularly dubbed *conveyancers*. Amongst other contrivances, shifting cases, fitted to the channel communicating with the box slits, have been sucecssfully applied for the detention and carrying off of the deposited letters. Obtaining, by stealth, a tolerably accurate measure of the area of the slit, a tin case is made, and adroitly slipped into the channel, and as cleverly withdrawn, with the deposited letters, after a short interval. Thin rods, with an adhesive substance on the end, have also been applied with considerable success in the drawing np of letters. Messrs. Bryden, of this city, have introdnced an ingenions box for the prevention of these thefts, and our engraving explains how they have succeeded in their object.



1-8th.

The figure is a vertical section of the box as fitted to the back of a door. The letter slit. A, is horizontal, as nsual; and its external hinged door of brass, B, has riveted to it, at one end, a short arm, C, projecting throngh the thickness of the door, ontside the box. From this arm, a jointed link descends to a short lever, D, fast on a spindle passing throngh the upper portion of the box; which spindle carries a moveable shelf or valve, E, of an area eqnal to the sectional area of the box.

From this arrangement, it will be seen that the moment the door, B, of the slit is pressed inwards, as in the deposit of a letter, the motion of the arm. C, will draw up the lower lever, D, so as to raise the valve, E, to the horizontal position, as given by the dotted lines.

The valve tbns receives the deposited letter on its snrface; and when the slit door is released from the pressnre upon it, by the withdrawal of the hand, the valve falls to its vertical position, and the letter drops to the bottom of the box, which is made deeper than usnal. When any attempt is made to introduce a wire or stick, witb the intention of drawing np the contents of the box, the same elevation of the valve, E, occnrs, and cuts off all communication with the bottom portion of the box. A small half-round projection is formed at F, in the interior of the box, to fill np the space which would otherwise be left when the box door is only very slightly elevated.

CHAPLIN'S PORTABLE FORGE.

The ordinary moveable forges employed by the boiler-maker and iron ship-builder, present an appearance very little akin to convenient portability, for they occnpy a great space when in action, and are difficult of stowage when not required for work. Mr. Chaplin's contrivance provides a practical remedy for both of these objections, and we have little hesitation in stating that it will eventually supersede all the varieties of bellows apparatus, as well for its power of producing the most intense heat in a short space of time, as for the conveniences it offers in point of conveyance from place to place.

Our engravings show the forge under its two conditions of arrangement. Fig 1 is an isometrical perspective view of it in working trim; and fig. 2 shows it folded together for stowage. A, Is the upright iron

Fig. 1.

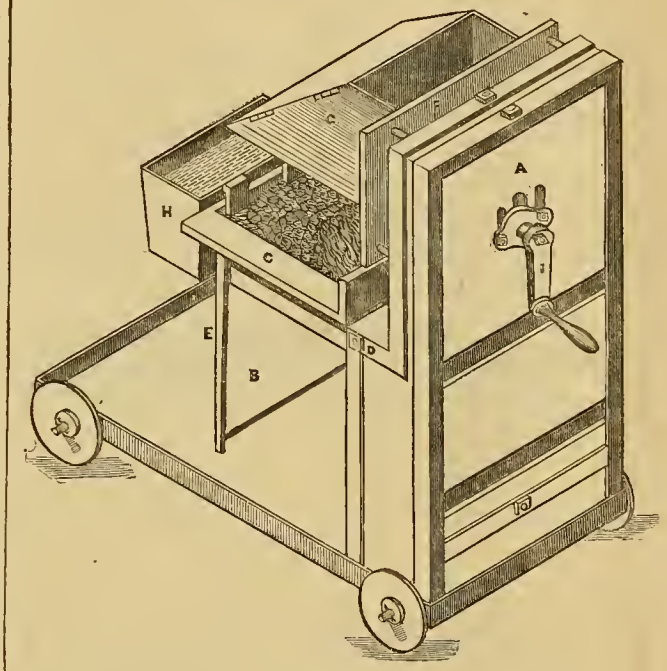
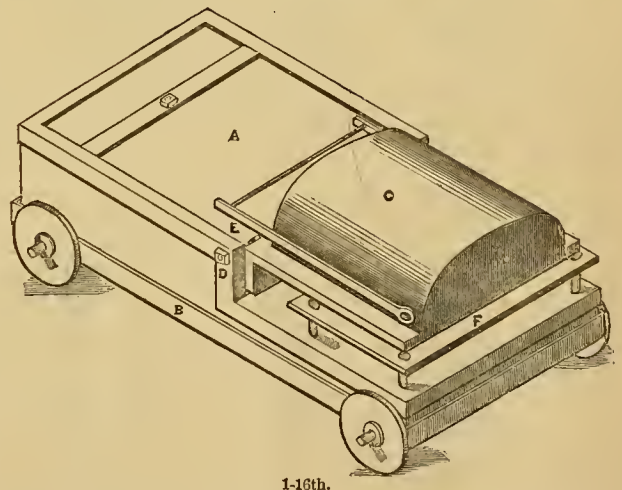


Fig. 2.



1-16th.

frame, containing the blowing apparatus. B, Is a sheet-iron tray mounted on wheels for shifting; and to this tray the upright frame is attached by a single bolt. The fuel is contained in the long concave pan, C, of cast-iron, bolted to the frame, A, at D; the bolts acting as hinges for folding up. The opposite end of the pan is supported by two standards, E, which are simply jointed to it at their upper ends; their feet passing through round holes in the tray. An adjustable dead-plate, F, is fitted to the inner front of the frame, to prevent the injurious action of the heat upon the blowing mechanism. A portable hinged hood, G, is also fitted, for reflecting the heat downwards, and for carrying off the smoke. The cold water trough, H, is hooked upon the end of the fire-pan. The blowing apparatus consists of a small fan placed near the bottom of the frame, A; it is driven by a band from a pulley upon the spindle of the winch-handle,

1, the tension of the band being adjustable by bolts in vertical slots in the frame.

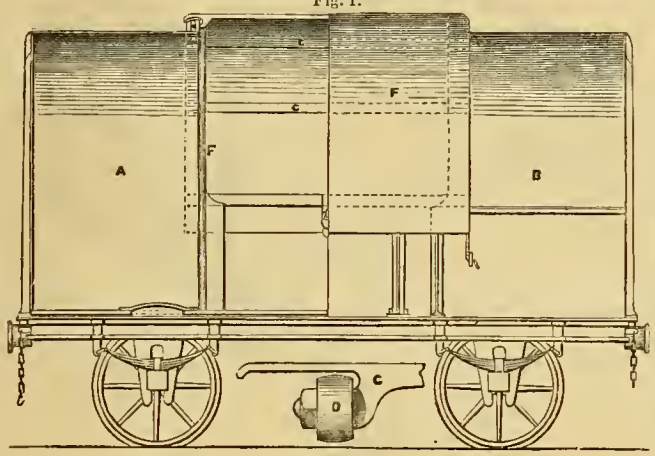
In another arrangement of this apparatus, the foot is employed as the impelling power for the blower, a treadle being fitted near the ground to work the driving pulley by a crank on its spindle, thus leaving both hands of the workman at liberty. The forge, with a little modification, answers excellently as a shot heater for war purposes, or for melting brass and iron. For heating shot, or melting brass, a set of fire-bars are fitted, and the blast is directed upwards between their interstices. A conical cover, lined with fire-clay, is also fitted over the fire, to be raised to admit of the insertion or removal of the shot. In melting, a simple octagonal cupola, lined with fire-clay, supplies the place of the fire-pan.

Being constructed entirely of iron, these forges are proof against the attacks of insects, or the injurious effects of tropical climates, and for this reason they will be found most suitable for ships' work. To show the rate of heating, we may mention that a bar of iron, 1½ inches in diameter, can be brought to a welding heat in from three to four minutes.

HILL'S IMPROVED COVERING FOR WAGGONS.

A novel covering for railway waggons, possessing several ingenious and useful features, has lately been introduced by Mr. Christopher Hill of New Swindon, Wilts. Fig. 1 of our engravings is a longitudinal elevation of a waggon fitted with Mr. Hill's cover; fig. 2 is an end

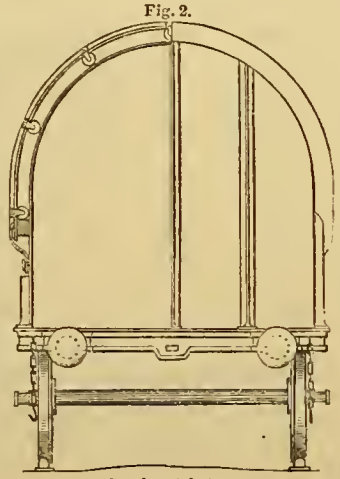
Fig. 1.



3-16th = 1 foot.

elevation, half in section; and the detached figure, between the wheels in fig. 1, is an enlarged view of one end of the cover guide-rods, with its running roller. In our main elevation, one half of the waggon cover is represented in section. A B, Are the standing end covers, one in elevation; the other sectioned to show its internal arrangement. C C, Are a series of iron rods, having their ends formed as in the detached figure, with brass rollers, D. These rods stretch across beneath the entire length of the moveable cover, E, and rest, by means of their end rollers, upon a grooved guide formed round the hood or standing cover. Projecting horns are forged on the ends of these rods, standing out directly over the rollers, D, and arranged to carry the cover over the blocking necessary to form the space for the latter. The covering is stretched, and attached upon the rods by rivets or sewing, and can be readily shifted, by drawing down at either side of the waggon, so as to leave one side quite open; or it may be fixed partly open, by pins or keys fitted to holes in the rim, F. When the waggon is loaded, it may be secured by a lock, the hasp of which is attached to the bottom rod.

Fig. 2.



3-16th = 1 foot.

This plan appears to offer the highest degree of security, whilst the facility of adjustment is perfect.

THE MECHANIC'S LIBRARY.

Architecture of England, Ecclesiastical and Domestic, 84s. Hadfield.
Art, The Elements of, 4to. 10s. 6d. cloth. J. G. Chapman.

Beauty, Inquiry into the Principles of, imperial 8vo. 30s. J. Fergusson.
Builder's Price Book for 1849, 8vo. 4s. sewed. Skyring.

Carpenter's Work, System for Valuation of, 3s. 6d. H. B. Browning.
Chemical Manipulation, 8vo. 6s. 6d. cloth. H. M. Noad.
Chemical Recreations, nineteenth edition, 18mo. 7s. 6d. J. J. Griffin.
Chemistry, Lessons in, 12mo. 2s. 6d. cloth. J. F. Hodges.

Design, Studies of Ornamental, folio, 63s. sewed. C. J. Richardson.
Draining, Tables of, oblong 8vo. 1s. sewed. J. Strachan.

Galvanism, Observations on, 12mo. 1s. 6d. sewed. J. P. Tyler.

Illumination, Art of, square 12mo. 21s. boards. H. N. Humphreys.
Inventors, Hints to, on Letters Patent and Registrations, third edition. W. Johnson.
Italian Finishings, Examples for, folio, 18s. cloth. E. W. Tendrall.

Mechanics of Fluids, second edition, 8vo. 10s. 6d. cloth. A. Jamieson.
Mineralogy, Manual of, 12mo. 7s. 6d. boards. J. D. Dand.

Painting, Art of, from the German, crown 8vo. 9s. 6d. L. Hundertpfund.
Painting, Lanrie's Luminaries of, crown 8vo. 9s. cloth. Evans.
Painting, On the Art of, 2 vols. 8vo. 30s. cloth. Mrs. Merrifield.
Philosophers, Facts for, 8vo. 9s. cloth. A. Williams.

Rembrandt and his Works, 4to. 31s. 6d. cloth. J. Burnet.

Scientific Works, Library of, Vols. II. and IV. "Knapp's Technology," 8vo. 42s. Ronalds and Richardson.
Scientific Works, Library of, Vol. VII. "Elements of Chemistry," 8vo. 3 parts, 17s. T. Graham.

RECENT PATENTS.

Abstract of all Specifications Enrolled from 18th of November to 17th Dec.

TUBES.—William Taylor, Birmingham, Machinist.
Enrolled, Nov. 18, 1848.

The plate to be formed into a tube is laid flat upon a long narrow iron bed, along the middle of which is a semi-cylindrical concave groove, the concavity of the groove being formed to fit the exterior circumference of the finished tube. The grooved bed is made to slide in the direction of its length: firstly, under a revolving convex roller, which presses down the middle part of the width of the plate into part of the depth of the groove, thus causing the edges to turn up, and form a species of shallow trough; secondly, under another convex roller, which presses the plate completely down into the groove, forming it into the shape of a trough, with a curved bottom, and nearly upright sides.

When passed from this roller, the plate is slid off the bulb of a fixed mandril, and, at the same time, between a pair of rollers, almost touching each other, and having their axes inclined from vertical lines in opposite directions. The edges of these rollers are conical; but concave to a quadrant of a circle of the same size as the groove in the bed, so as to leave a semicircular aperture between their conical and concave circumferences. The effect of these rollers is to bend the edges of the already partially bent plate towards each other, and down upon the mandril. The plate then slides, with the mandril inside, under another revolving grooved roller, which completes the bending down of the edges, and completes the tube. The patentee states in his claim, that "the peculiarity and novelty of the combination of parts, and of their manner of turning up or bending, being, that the flat plate is laid upon a bed, over a long groove therein, which bed, together with the plate, is moved endway forwards, beneath a series of rollers, by action of some of which rollers (either direct action, or by the intervention of a mandril) the middle part of the plate is bended down into such groove, first to a part of the depth thereof, so as to bend the plate to a shallow gutter form, and next to the bottom thereof, so as to bend the plate to a deep gutter form, the two sides of which deep gutter form are (by action of other of the said rollers) afterwards turned inwards, one towards the other, and downwards upon a mandril, either stationary or moveable with the plate, the two sides of the said deep gutter, which are so turned down, either meeting edge to edge, or with the edges overlapping, as may be required."

MANURE.—T. Richardson, Newcastle, Chemist.
Enrolled, Nov. 25, 1848.

Animal matters, as bone or guano, containing phosphates of lime and magnesia, are dissolved in the liquor of alum-works, known as "mother salts," or in a solution of rough Epsom salts, such matter being mixed with a small proportion of nitrate of potash, soda, lime, magnesia, or nitric acid. The animal matter is placed in an iron vessel, lined with lead, and is mixed with one of the nitrates, or with nitric acid, and mother or rough Epsom salts, in the proportion of bones or guano, containing 75 lbs. of the phosphates, to 100 lbs. of the mother salts, or 300 lbs. of rough Epsom salts dissolved in the least possible quantity of water. Proportion of the nitrate, or nitric acid, to be as 1 to 26, when bones are used, but only half that amount for guano.

The mixture is boiled until the animal matter disappears, and it then attains the consistency of paste. At this stage it is removed and dried at a heat of 300° Fahr., and afterwards reduced to powder, and applied as manure. The bones are to be ground between edge-stones, before treating in the manner described. Claim is for the "employment of mother salts, or rough Epsom salts in solution, separately or combined, and in conjunction with either nitrate of soda, or nitrate of potash, or nitrate of lime, or nitrate of magnesia, or nitric acid, to dissolve or decompose animal matters containing phosphates of lime and magnesia."

PROPELLING.—M. Poole, London.—(Communication from Lieut.-Colonel Sir T. Levingston Mitchell.)—*Enrolled, Nov.* 25, 1848.

The invention consists in the application of a screw on the principle of a "Boomarang." It occurred to the inventor, on observing the motion of a boomarang in the air, whirling round a hollow centre, and leaving a vacant centre of gravity, that its centre of motion would be found to be on a right line, which would divide the boomarang into three portions, in such a manner that the eccentric portions should equal the central one; and this he has since proved to be the case. In this newly-discovered centre of motion, is to be placed the bearing of the boomarang screw, in which the rotating shaft is carried. The inventor states the advantages of the arrangement to consist in its working in the water obliquely to the radius of the rotatory motion, and in being free from lateral pressure. The claim is general, and refers to the employment of propellers as described.

PRESERVING ANIMAL PRODUCTS.—S. H. K. Louis, Southwark, *Enrolled, Nov.* 25, 1848.

Cow's, ass's, and goat's milk, are stated to be the animal products proposed to be preserved by Mr. Louis; and the plan consists in the conversion of the milk into solid cakes, or masses, for storing,—to be afterwards dissolved in warm water. The milk is first mixed with well-clarified raw sugar—four ounces to a gallon of milk. It is then agitated, and evaporated in open pans by steam. The pans rest upon a series of horizontal circular boxes, which are supported upon, and communicate with, three hollow standards, acting as conveyers of steam from a boiler. A vertical shaft passes up through fluid-tight collars in the centres of the boxes and pans; to this shaft are attached radial arms, of a rake form, which traverse through, and agitate the milk.

The steaming temperature is from 176° to 194° Fahrenheit; and while the watery particles are evaporating under this heat, the milk is kept constantly stirred round by the revolution of the shafts before mentioned. As the operation proceeds, the milk gradually thickens, until it ultimately assumes the form of a paste, which, as it approximates to hardness, is taken out of the pans, and pressed into moulds.

If great despatch is not imperative, a series of very shallow pans is supplied with the sweetened milk, to a depth not exceeding 1-10th of an inch, being left exposed to the ordinary temperature of the atmosphere, until the fluid evaporates to dryness. If the atmosphere is not in a good hygrometric state for the operation, the pans may be placed in drying-rooms heated to 122° Fahrenheit. If milk cakes of very rich quality are desired, the milk is sweetened, and then warmed to nearly the boiling point, and left to cool slowly; when tepid, it is curdled with rennet, or a weak acid. The curd is separated, and well washed in cold water, and subjected to a great pressure, to free it of its watery particles, and the whey is evaporated to dryness, to recover the salts with which it is charged. The curd is then placed in a pan over a slow fire, and is constantly stirred, whilst the salts, recovered from the whey, are gradually thrown in, with a small portion of bicarbonate of soda or other alkali —one part alkali to twenty whey salt. When the contents of the pan begin to amalgamate, a little gum-dragon is added to facilitate solidification. Cream may be solidified by this process also. The claim is general, for the conversion of milk and cream into sold masses for preservation.

GAS, TAR, CHARCOAL, AND CERTAIN ACIDS.—A. Solomons, London, Merchant, and B. Azulay, Rotherhithe, Printer.—*Enrolled Nov.* 25, 1848.

This patent comprehends the destructive distillation, in close vessels, of wood, peat, turf, refuse of dyewoods, and other vegetable matter, by means of steam at a high temperature, whereby the substances named in the title, as also pyroligneous and acetic acids, are produced. A strong cast or wrought iron cylinder is firmly embedded in masonry, and encloses an inner cylinder which is kept at a proper distance from its containing cylinder by stays. The inner cylinder has an internal casing of sheet-iron, within which the vegetable matter is placed. The outer cylinder is heated by a furnace, the flue of which contains a coil of the steam induction-pipe connected with a boiler, which supplies steam to the space between the two cylinders, whence it passes to the interior chamber where the vegetable matter is placed. The liquid and gaseous products escape either into the air or into refrigerators, and are manufactured into gas, tar, and acids, in the ordinary way. When saw-dust or refuse vegetable matter is to be operated upon, it is placed in small cylinders, deposited in the interior of the inner cylinder, to be treated as described. The claim is the "production of gas, tar, charcoal, and pyroligneous and acetic acids, by destructive distillation or carbonization, through the agency of steam of high temperature."

LOCOMOTIVE, MARINE, AND STATIONARY ENGINES.—G. Reminoton, Northumberland, C.E.—*Enrolled, Nov.* 25, 1848.

In this patent are embodied a series of three mechanical contrivances: —1st, An arrangement for converting reciprocating rectilineal motion into rotatory motion. 2nd, The converse of the first. 3rd, An arrangement for reversing engines. 1. On the rotatory shaft, whose motion is to be changed, a lever is set at right angles to its axis, and fitted on its end, with a small rectangular block. On this end of the lever is placed a square plate of metal having two slots, one horizontal, the other vertical, intersecting each other at the centre. The shaft passes through the vertical slot, so that the plate may travel freely up and down over it; and the block, which is rather longer than the breadth of the vertical slot, is placed in the horizontal one. If, when the actuating lever is almost vertical, a downward motion is communicated to the plate, to the full extent of the vertical slot, the block will travel from the centre to the end of the horizontal slot, the lever will assume a position the reverse of its original one, and the shaft will have made a half revolution. The dead point is overcome by a fly-wheel, and an upward motion being given to the plate, the movement is continued.* 2. This arrangement acts in a manner exactly reverse to that just described. 3. The reversing apparatus is described with reference to, and can only be understood in connection with, the drawings. The claims are the general arrangements described in the specification.

MALT LIQUORS.—G. H. Bursill, James Paterson, and John Mathews, all of London.—*Enrolled, Nov.* 22, 1848.

Malt liquids, and other fluids, in small quantities, are impregnated with carbonic acid gas as they are required for consumption. This is done during the operation of elevating or forcing the liquid, by an arrangement whereby a due and proper quantity of the gas is drawn off from its receiver, at the time the liquid is taken from its cask, the two mingling in the pump barrel. The claims are "the impregnating of liquids with carbonic acid gas in small quantities, and as they are required for consumption, and the machinery, described in the specification, or any other suitable apparatus for effecting the same."

COPPER ORES.—J. P. Penny, Notting Hill.—*Enrolled, Nov.* 25, 1848.

The carbonates and oxides of copper ores are decomposed by leaves, chips of wood, charcoal, or other carbonaceous substances, during the process of smelting. The furnaces are of the ordinary kind used in Swansea and Holywell, only that the crown is set nearer the bottom, for the purpose of keeping the flame and heat down upon the mass: the furnace is also of greater capacity, to allow of wood being used as a fuel.

The furnace is raised to a white heat, and the copper ore is introduced through the crown in broken pieces, and, when fused, a sufficient quantity of the carbonaceous material is thrown in upon it; or the ore may be reduced to powder, and mixed with the carbonaceous substance previously. The copper, when separated from its compounds, is run into a cavity in the furnace; after which, it is tapped and run off as usual. The claim is "the decomposing the carbonates and oxides of copper ores by means of leaves, chips of wood, charcoal, or other similar carbonaceous matters, during the smelting process."

TWISTING AND DOUBLING COTTON YARNS.—M. Haoue and J. Firth, Huddersfield.—*Enrolled, Nov.* 25, 1848.

This patent refers to twisting jennies. The carriage, headstock, and spindles, are combined in such a manner that they perform the following operations:—

1st. The "running out" of the carriage, whereby a continuous supply

[* This plan is evidently identical with that devised some years ago by Mr. Booth. It is simply the principle of the old elliptograph applied as a crank motion.—Ed. P. M. J.]

of mule or throstle yarn is delivered to the spindles.—2nd. The rotation of the spiudles.—3rd. The "stripping off," whereby the rotation of the spindles is momentarily checked, and a small portion of the twisted yarn lifted off their stems, simultaneously with which the—4th operation, or "faller movement," as it is termed, takes place; by which the delivery of the twisted yarn upon the spindles is regulated.—5th. The "putting up" of the carriage.—6th. The "winding on," whereby the twisted yarn is wound upon the spindles in successive coils at a differential speed proportionate to the varying size of the cop.—7th. The "cop or shaper movement," whereby the cop is built up in a uniform and proper shape upon all the spindles simultaneously.—The claims are—"1. Effectuating the rotation of the fast motion shaft uniformly in one direction, whereby any back lash or shock to the working parts of the machinery is avoided. 2. The mode of running out the carriage by means of a scroll wheel and endless band, thereby dispensing with the use of racks and straps ordinarily employed for that purpose. 3. The putting up the carriage by reversing the action of the scroll wheel, &c. 4. The faller movement. 5. The mode of winding on the yarn at a varying speed, by means of a leather friction cone and lever acting upon the rim pulleys and endless bands. 6. The cop motion. 7. The systematic mechanical arrangements, or any modifications of them or their equivalents, whereby the machinery is made to perform the required operation independently of manual power."

WEAVING AND PRINTING CARPETS.—W. Wood, London, Manufacturer.—*Enrolled, Nov.* 30, 1848.

The patentee states, that in the manufacture of hollow-looped or general pile-cut fabrics, sufficient material for the formation of the loop only is used, and linen yarn being the material used in the production of the remainder of the fabric, it is deficient in warmth, substance, and elasticity. By this invention, additional substance or "dead" is given to the fabric, by the employment of a thicker kind at the back, or in the body of the fabric.

To remove an objectionable feature hitherto present in the application of mechanical printing to hollow-looped fabrics, namely, the difficulty of imparting sufficient colour, by reason of a want of facility in passing the printing cylinder exactly over the same parts, the following arrangement is employed:—Guide-rails are placed longitudinally above the table on which the fabric is stretched, and these rails carry the printing frame, upon which are placed the printing cylinders, together with the colour can and distributing rollers. Toothed wheels are carried on the shafts of these cylinders, such wheels gearing with toothed racks fast on the guide-rails, and by this means due register is kept. The claims are—"1. The mode of manufacturing hollow-looped carpets, and pile-cut fabrics, woven with printed yarns, or coloured or plain, and afterwards to be printed, with additional weft, as described. 2. The printing of these fabrics by means of cylinders, or rollers, actuated or controlled, so as to insure the pattern passing over the same portions of the fabrics."

CLOSING TUBES—REMOVING INCRUSTATIONS IN BOILERS. W. Seaton, London.—*Enrolled, Nov.* 30, 1848.

When the tubes are of iron, they are raised to a welding heat, and are placed on a vertical mandril, with the end to be closed projecting slightly beyond it, when they are acted upon by a die under pressure. When the tubes are of copper, or an alloy of copper, they are acted upon in the same way, without being heated; and, as the end cannot be entirely closed, a small hole is left, to be afterwards filled up with a rivet of the same metal. Boiler incrustations are removed by precipitating the lime of which they are formed, by oxalic acid, carbonate of potash, carbonate of soda, or other chemical agents, and filtering it through charcoal and sand: this to be done when there is not sufficient time to allow of precipitation by gravity. Nitric, muriatic, or acetic acid is also employed to hold the lime in solution, so that it may be blown off. Saw-dust or charcoal is also used for preventing, by its mechanical action, the formation of deposits in the boiler. When operating upon salt water, salt, soda, or saltwort is used. For the removal of old incrustations, an excess of the chemical agent is to be employed. The claims are—"1. The closing the ends of the tubes of steam boilers and generators by dies, as described. 2. The mode of preventing and removing the incrustations in steam boilers and generators, as described."

MATS.—W. J. Barsham, Essex.—*Enrolled, Dec.* 1, 1848.

By this process, mats are manufactured of fibres held tightly between laths, channels being thus formed in the material. A cord of the cocoanut, or other fibre, is wound round a number of laths, which are then laid parallel in a compressed machine, the cords on the end laths being first made fast. The ends of the laths rest in grooves in the frame, and are thus prevented from jumping during the action of the pressure. When compassed, a metal frame binds the whole together, and the cord is slit up to the extent of the length of each lath. The claim is general, referring to the mode of manufacturing mats in the manner described.

SPRINGS.—T. B. Turton, Sheffield.—*Enrolled, Dec.* 1, 1848.

In this invention, the metal plates of the springs are bent into segments, by means of rollers or blocks. The machine consists of a long iron table, with three vertical spindles, one of which is carried by a fixed bearing, the other two in adjustable ones; a roller is keyed upon the ends of these spindles, which project above the surface of the table. The roller running in the stationary bearing is the driven one, and the plates are passed through the set of three, as in the ordinary process of bending plates.

The blocking apparatus is a metallic bed, hollowed to the curve to be given to the plates to be bent, and having a corresponding convex block. Two uprights are attached to each side of the bed for carrying a cross-piece. The top block carries a guide-rod, having a stud, sliding in a curved slot in a metal plate. The top of the slotted piece is fast upon a pin passing through the centre of the cross-piece, to which one end of a long lever is attached. A friction roller is also carried by the guide-rod, beneath the slotted piece. When the lever is raised, the slotted piece is caused to describe a curve in an upward direction, by which movement the top block is elevated through the medium of the stud on the guide-rod. The plate to be bent is then placed in the bed, and the lever is pushed down along with the slotted plate, the outer edge of which, acting upon the friction roller, the plate is forced into the concavity of the block. The claim is "the arrangement and combination of mechanical parts, before described."

SAWING.—T. H. Barber, London.—*Enrolled, Dec.* 1, 1848.

This invention embodies a great many contrivances, the description of which is very lengthy. We are only enabled to state the main points which the patentee claims:—1. The means of giving support to timber when being sawn to various bevels.—2. The improvements in chucks or apparatus for holding timber at the ends when being cut or sided.—3. The means of giving motion to the timber to facilitate its being cut to the bevels.—4. The improvements in sawgates or frames.—5. The means of moving the bevelling bar, or apparatus for governing the bevels.—6. The mode of giving stability to the head blocks for holding the logs when being sawn. 7. The apparatus for indicating the directions, or bevels, of the timber to be cut.

VEHICLES FOR RAILWAYS OR COMMON ROADS.—R. C. Mansell, London.—*Enrolled, Dec.* 1, 1848.

In the first portion of this invention, "elongating springs" are proposed as a means of rendering carria es more or less rigid, as may be desired. The springs are made of one or more flat plates of steel, of a curved, corrugated, or elliptical form; and are so attached that, without any transverse hearings, the shocks are received from their ends, causing them to alter their figure in the direction of a straight line, and elongate in length from end to end, the elasticity of the material causing it to recover its original shape when the shock has passed off. A great variety of arrangements are given, whereby this effect is produced.

Secondly: These springs are employed as buffer and draw springs. Flat guide-plates of wrought-iron, furnished with stop-shoulders to receive the pressure of the spring coupling-plates, are bolted to each end-frame of the carriage. In the stop portions of the middle guide-plates, are riveted the ends of two radial levers, allowing them to turn on centres, whilst their contrary ends are attached to the free ends of two of the springs. On the under part of each coupling-plate is a step-piece which travels between the flat guide-plate. The ends of the levers project beyond the point of connection with the springs, and are kept in contact with the inner ends of the buffers. The shocks are, in this manner, received on the outside ends of the levers, which are thrust backwards, and the springs are elongated by the action. The arrangement of draw-springs is the reverse of this.

Thirdly: The invention has reference to expanding wheels, upon which the tyre may be fixed in a cold state; also to a plan whereby the tyres may be attached without holes. A wrought-iron hook is tightly shrunk on the cast-iron bars of the wheel, in which right-hand screw-holes are fitted to receive the screwed ends of the spokes. The opposite ends of the spokes are left-hand threaded, and are fitted into iron shoes. Flaps

are formed on these shoes, to receive the inner wooden periphery of the wheel. The tyre is of wrought or cast-iron, having a groove on each face, near its inner edge, for the attaching of securing-rings. The wooden periphery is first screwed up, to enable it to be placed within the tyre; it is then screwed outwards, to expand it against the latter, the flanges of the securing-rings being subsequently fitted into the grooves of the tyre, and bolted to the shoes and the wooden periphery. The claims are —"1. The construction of vehicles having elongated springs adapted and applied thereto, in such manner as that the action of the weight or force produces a tensile strain tending to straighten the springs. 2. The construction of vehicles having elongating springs adapted and applied as buffer or traction springs, in such manner as that the concussion or impact shall produce a tensile strain tending to straighten the springs. 3. The construction of vehicles with wheels, having the several parts held together by circular flanged plates, or rings of iron, and right and left-hand screws in combination, as described."

PEAT FUEL AND MANURE.—J. W. Rogers, Dublin. *Enrolled, Dec.* 1, 1848.

This refers to the drying of peat, which, when reduced to charcoal, is peculiarly applicable to the manufacture of metals for forge fires and moulding; also, as a mixture with animal matters, which may be thus deodorized. Having ascertained the natural outfall of the bog or peat moss, the patentee cuts the turf from it in trenches, effecting at the same time the drainage of the ground. The portions of turf are piled on open trays in a moveable shed, which are capable of transport. An ash-pit extends along the shed, which is lowered on its sides. The heating chamber, which is of a pyramidal form, is placed over the ash-pit, and is furnished with wheels running on rails laid alongside the pit. A perforated division of metal is placed over the heating chamber, to prevent the contact of the peat. By this contrivance, peat may be dried, or completely charred, if necessary.*

The peat-compresser consists of two standards, which carry upon one axle two wheels, with quadrangular bottomless moulds projecting from their rims. An oscillating beam, suspended from the frame, carries two impressers, which work alternately into the moulds below them. In another modification, air channels are made in the shoulder-pieces, leading to an exhaust-cylinder, the piston of which has a motion the reverse of that of the impressers, so that the air and moisture are exhausted from the turf during compression. The claims are for "the moveable sheds, so constructed as to protect from wet the peat piled upon the tray, without, however, intercepting the free circulation of the air among the blocks of peat to dry them. The sheds arranged as described, whether adapted to dry one or more clumps of turf. The heating, or peat-charring chamber. The hot air passage alone, or combined with a fan-blower. The peat-compressing machine alone, or with the exhausting apparatus. The application of granulated peat charcoal to animal excrements, in such quantities as to retrain the ammoniacal and other gases in the compounds, and render them inodorous and applicable as manures."

RAILWAY WHEEL.—B. Lathrop, London.—*Enrolled, Dec.* 4, 1848.

Mr. Lathrop's improvement refers to the casting of iron wheels in chills, in one piece, of such a shape that they will cool without an injurious strain. This he accomplishes by various applications of the well-known principle of corrugation,—and claims "Firstly, wheels of cast-iron of such a form that the part equivalent to the spokes of a common wheel, and which I call the disc, shall be corrugated in concentric circles on the plane of the wheel's motion, and at the same time in the line of the radii on a plane at right angles to that plane. Secondly, I claim the combination of the double corrugated disc mentioned in claim 1, with projections above described as the second form of disc. Thirdly, I claim the combination of a disc corrugated on radii in the plane of the wheel's motion, with projections described as the third form of disc."

PAPIER MACHE.—W. Brindley, Birmingham. *Enrolled, Dec.* 6, 1848.

This has reference to the formation of ornamental surfaces, to the making of wash-hand basins, and to the manufacture of hats, of papier maché. The moulds employed to shape the material, are engraved in their sunken portions for the production of designs in relief upon the finished article. When finished, the articles are saturated with oil, and stoved; moulds are proposed to be made of papier maché, from one of the finished articles, so as to avoid the necessity of employing several iron moulds. Wash-hand basins are formed by the deposit of pulp between two moulds, pressed together, and heated, being afterwards saturated with oil, and dried. Instead of japanning, they are painted; the smell being removed by exposure to a high temperature. Hats are made in the same manner. The claim is general.

[*This method of drying peat is very similar to that devised some time ago by Mr. Mallet of Dublin.—Ed. P. M. J.]

GAS AND RETORTS.—R. Barnes, Wigan, Gas Engineer. *Enrolled, Dec* 6, 1848.

Mr. Barnes proposes to distil gas from coal in an economical manner, for small consumers. The retort is suspended in a brick stove by flanges, and is covered with a gas-tight top of the hydraulic kind, the tar which drips from the cover, being so applied as to prevent the escape of the gas. The retort contains a cradle for holding the coal; and the gas passes off by a pipe in the cover, to a refrigerator, hydraulic main, condenser, wash vessel, purifier, and gasometer, all of which are conveniently contrived to stand in a small space. The same cover is applied to retorts for the distillation of pyroligneous acid. The claims are—"1. The constructing the stove with openings in front or in the sides, but without grate or bars, and in closing the mouth of the retorts used in the manufacture of coal gas, or pyroligneous acid, or other similar purposes, by a cover made gas-tight by a water-joint, as before described. 2. The peculiar construction and general arrangement of refrigerator, condenser, wash vessel, purifier, and gasometer, as described."

PREPARING AND CLEANING MINERALS.—C. H. Capper, Warwick.—*Enrolled, Dec.* 11, 1848.

Four arrangements for cleaning ores are given. The first sieving apparatus is simply a wire-gauze cylinder, divided in the middle into different sizes of mesh, and placed in an inclined direction over a water receiver, having a partition coinciding with the point of junction of the two gauze media. This cylinder having a rotatory motion given to it, the ore is introduced at its high end, and the two sizes of fine and coarse pieces are separated, and deposited in the two partitions of the receiver below, whilst the largest pieces, passing over both divisions, fall out at the lower end. For dressing the ore thus sifted, a vessel with a bottom of wire-gauze, perforated with holes, is used. This vessel has a species of shoot on each side, sloping downwards, and the ore being conveyed into it, a jigging motion is given to it, and the small particles are thus passed through the bottom, whilst the larger ones are conveyed by the shoots into an outer receiver. In another arrangement, a semicircular trough is suspended horizontally over a vessel of water, into which it dips; and an oscillatory motion being communicated to it, the earthy particles are carried off by the action of the water. A third arrangement consists of a vertical wheel, flanged on each side, and made to revolve slowly. The ore is carried upon the highest point of the wheel, between the tin flanges, at which point it comes in contact with an opposing flow of water, which holds the minute particles in suspension, and carries them round the wheel in a direction opposite to the motion of the latter, and delivers them into a receiver, whilst the ore is taken along with the wheel to a shoot. Patentee claims—"1. The construction of a jigging apparatus, with a perforated bottom, through which the small pieces of ore pass, and the application of tubes or shoots to convey away the other particles, as described. 2. The construction of an apparatus, in which the ore to be dressed is placed in a trough partially immersed, to which oscillating motion is communicated, whereby the earthy particles are held in solution, and separated from the ore, as described. 3. The construction of apparatus, in which the ore to be dressed is brought on or near to the highest point of a wheel revolving in a vertical plane, where it is subjected to the action of a current of water conducted to near the same point, and flowing in a contrary direction."

FRINGES, GIMPS, AND BULLIONS.—T Dalton, Silk-Dyer. *Enrolled, Dec.* 8, 1848.

Fringes are ordinarily woven, two at once, the material left between the two strips or selvage being subsequently slit up. This invention comprises the printing of the fringe after it is woven, but before the slitting operation is performed, as the stretching process upon the printing table is thereby facilitated. Again, when printing two fringes with different patterns, an additional piece is woven between the two, to be divided longitudinally, to permit of the stretching and printing of each separately. Gimp silk twist may be printed in the same manner after weaving. Lastly, the patentee manufactures fringes and bullions with printed weft, by the ordinary means. Claims are—"1. The manufacture of fringes of silk twist or sewings, and of linen sewings, by

printing them after they are woven, and also printing gimps composed of silk twist. 2. The application of printed weft to the manufacture of fringes and bullions."

MAKING SKEINS OF SILK.—J. Foot, London.
Enrolled, Dec. 8, 1848.

Patentee states, that in giving out skeins of silk to be dyed, considerable loss often ensues from the depredations of the men employed upon it; and as the material changes much in weight during the operation, detection is not easy. By the means described in this specification, the abstraction of silk is impossible, as the ends of the card employed in attaching the skeins, are woven into one piece by a machine similar to a ribbon loom. Claim is "the connecting the ends of the cords employed in fastening or binding the skeins of silk, and forming a woven fabric upon them."

MOTIVE POWER.—A. P. M. Darlu, France.
Enrolled, Dec. 8, 1848.

After reading this document carefully, we must confess we can make nothing of it; either the inventor has been very much at sea in the matter, or his translator has converted his description into something remarkably like nonsense. We can only state, that the claims are—"1. The application of light-valved chambers to gaseous agents without the addition of pumps and piston, and in my above specified valve. 2. The application of these simple apparatuses to hydraulics, either by aspiration or insufflation 3. The utilising of the wasted steam of fire-engines to augment the power or lessen the expense, by means of light-valved chambers, with or without the injection of water. 4. The application of compressed air by insufflation to the direct propulsion of vessels. 5. The apparatus specified under the denomination of pneumatic remonteur agent totally exempt of all complications."

CURING SMOKY CHIMNEYS.—Sir H. Hart, Rear-Admiral, R.N.
Enrolled, Dec. 17, 1848.

Wheels are so placed as to receive a rotatory motion from atmospheric currents, for the purpose of drawing off the air from the flues. In one scheme, a fan-wheel is placed partially within the revolving top of the chimney, so that a current of air, acting upon the fans projecting outwards, may, by their revolution, cause a draught. In another, a portion of the top is cut away, and the fan-wheel is placed therein, leaving a few fans projecting. In a third, the fan-wheel is placed within the side of the chimney fronting the wind, the top fans being covered with a shield, so that the air may act on the bottom ones only. Claim is "the employment of wheels made to rotate by the air, so as to withdraw the air from the chimney or flue, and brought into position by means of an arrow or vane."

REGISTERED DESIGNS.

FLAP-VALVE FOR SEWERS.
Registered for Messrs. Humphreys *and* Thirst, *Builders, Chelsea.*

Fig. 1 is a longitudinal section of the valve, with the extremity of the tubular sewer, on which it is placed. Fig. 2 is a front elevation: both

Fig. 1.

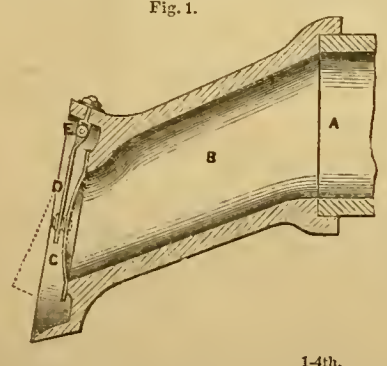
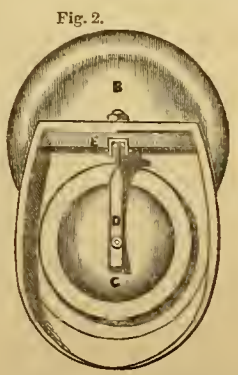


Fig. 2.



1-4th.

views represent the valve as closed. A, Is the end of the horizontal line of pipes, forming the sewer, to which the inclined pipe, B, is attached by a joint of the usual form. The outer-valve end of the pipe, n, has a considerable dip for the discharge of the water, and has a circular valve of zinc, or galvanized iron plate, c, slightly hollowed, attached to an arm, n, by a loose rivet joint. The loose joint admits of the valve falling flat and fair upon its seat, which is formed by the ledges moulded on the interior of the pipe. The arm, n, is jointed at E, to the upper overhanging ledge of the delivery end, by a mortise joint and nut; the pin of the joint resting upon rounded bearings inside, so that no stiffness may arise from the accumulation of grit or dirt at that part. This species of attachment affords great facilities for renewing, repairing, or detaching the valve, without lifting or disturbing the pipes.

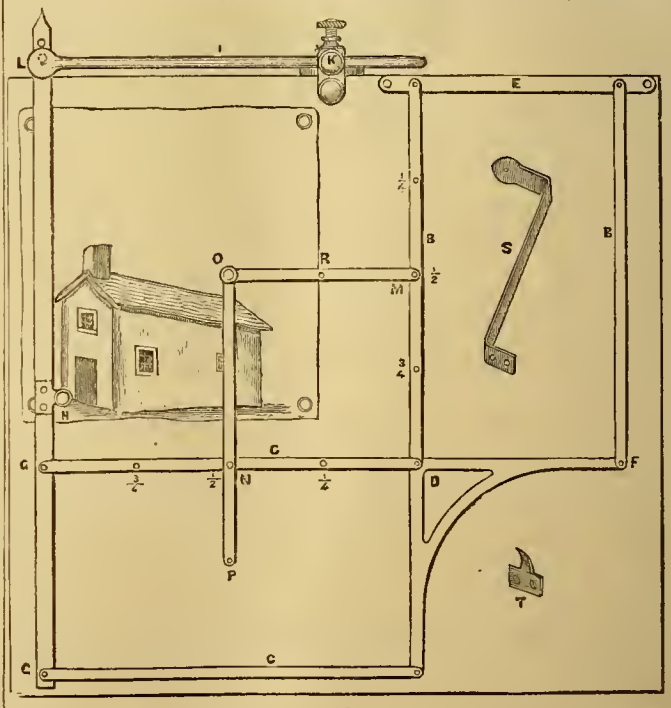
The parts which are registered as new, are those marked B, C, D, and E; and the rivet joint of the valve.

This plan appears to offer every advantage for a free discharge of the sewer contents, and the simplicity of its parts argues much in its favour for remaining in order.

PENTAGRAPHIC DELINEATOR.
Registered for Messrs. J. & W. Robertson, *Ardrossan.*

This contrivance is intended as an adjunct to the artist's or draughtsman's drawing apparatus, and may be adapted either for landscape, mechanical, or general outline drawing, as a tracer, or simply as a marker off, of main points in the delineation. Our cut represents the instrument, as mounted on an ordinary drawing board, for copying a landscape, or any object placed behind the tracing point, A.

It consists mainly of two sets of parallel bars, B n, and C C, connected by means of a bell-crank, n, so as to produce a pentagraph of great steadiness and accuracy. E, Is a fixed bar, screwed to the board, upon which the instrument is adjusted. This bar has loosely jointed upon it the two parallel bars, B B, one of which is jointed at its opposite extremity to the bell-crank at F, whilst the other is similarly connected to it at its centre, D; the second pair of parallel bars, C C, being similarly attached



1-6th.

at the opposite end and centre of the bell-crank respectively. The contrary ends of the latter bars are jointed at the points, G G, to the vertical bar, carrying an adjustable pencil or tracer, H, and having the tracing point, A, at its upper end. I, Is a bar adjustable in a fixed socket at K, having a minute sight aperture, L, at its opposite extremity. In delineating any object by this apparatus, the draughtsman looks through the sight aperture, L, and traces the apparent outline of the object by the tracer, A, the movement of which transmits the figure so traced to the paper or surface to be drawn upon by the pencil, H, which is here represented in the act of drawing a rustic building.

As the tracer bar has the same amount of motion at every point, the delineation on the paper will agree exactly with that of the tracer, A;

but when it is intended to reduce the drawing from the original, the two bars, M, N, carrying a tracer at O, are made use of. In the arrangement before us, they are jointed to the inner bars, B and C, at the points marked ½, which indicates that, with the pencil at O, the delineation will be one-half the size of the original, as seen through the sight aperture, L. To change this proportion to ¾, the projecting end, P, of the bar, N, is turned over and jointed to the point, ¾, on the inner bar, B; whilst the intermediate eye, R, is similarly attached on the inner bar, C.

Another set of eyes are marked ¼, indicating that with the bars, M, N, adjusted to them, the drawing will be reduced to that extent. Any other proportions are attainable by suitable additional eyes.

A detached angular sight-bar is shown at S; it is intended to be screwed to the tracer bar so as to move with it, for the copying or reducing of busts or other similar figures. T, is a small detached tracer with a bent point, to be employed in tracing, copying, or reducing drawings.

This delineator is well adapted for marking off main centres, or the more salient angles of any complicated piece of machinery, whose complete details could not be entirely traced in this manner. Again, it may be judiciously employed in conveying to paper a correct outline of any small piece of mechanism, works of art, or other objects, either where correct perspective is desirable, or where a mere geometrical elevation is required.

Whilst we are upon the subject of mechanical aids to artists, we may mention a plan which we saw in practice in England a few weeks back. It has been introduced by a Mr. Richter, who has been tolerably successful in enabling untutored parties to delineate with correctness, flowers, figures, or landscape outlines. In producing representations of flowers or other miniature figures, Mr. Richter places the object beneath a sheet of clear glass supported in a frame, and by means of a species of lithographic ink, he delineates on the glass ground, the outline of the flower or figure beneath, as seen through the glass medium. The nature of the ink admits of an easy transfer of the delineation to paper, in the usual manner of transferring by contact, with pressure.

When a large or distant object is to be drawn, it is reflected upon the drawing ground, after the manner of the camera lucida, and the delineation is then effected with nearly the same facility as in the former case. By the same system, the figure may be pretty correctly drawn, and portraits in an extempore style may be taken.

We saw a branch of a fuchsia with several flowers and buds, reproduced in the way we have described, by a party totally unaccustomed to anything in the way of drawing; the repose of the sprigs, and the graceful outline of the leaves being rendered in a very elegant manner.

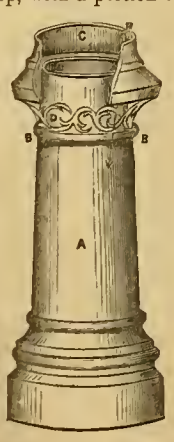
The idea is nothing more than a resuscitation; but as it is certainly applicable to many useful purposes, it deserves a passing mention. Moreover, Mr. Richter has added to the original process, many ingenuities of his own.

CHIMNEY TOP.

Registered for Messrs. Ferguson, Miller, & Co., *Heathfield.*

The design embodied in this chimney top, has for its object the correction of any tendency to "blow-down," or cause smoke in the apartments below, by any of the atmospheric currents which injure the action of the fine.

Our wood-cut exhibits a complete view of the top, with a portion of its upper end broken away, so as to exhibit the true configuration of the neck. The barrel, A, is moulded with a slight shoulder near its upper end at B B, upon which the head, C, is placed, forming one piece with the barrel. The lower angular face of the head, C, is perforated at intervals at D, in order to admit of the passage of a current of air either in an upward or downward direction, according to the action of the wind. If the wind strikes the side of the head, the current passing through the perforations, D, will glide upwards between the exterior of the barrel top, and the interior of the head, as indicated by the arrow. Again, if a "blow-down" is threatened, the entering current is diverted downwards through the same channel.



1-24th.

This chimney top has an extremely neat appearance, the apertures in the external head being formed as ornamental pierced work. This ornament, as well as the general external shape of the head may be varied almost infinitely, still preserving the configurative action, which the proprietors have here protected.

BARR'S DUPLEX BLOCK FOR PRINTING YARN IN THE HANK.

Registered for Mr. Thomas Barr, *Park Lane, Glasgow.*

The object of this apparatus is the imprinting or marking spots of colour or dye at regular distances asunder, upon yarn when in the hank. Yarn thus coloured is an article of great consumption in different branches of manufacture, and the inventor of the duplex block proposes to reduce the cost of its production very considerably, by means of the duplex action of his printing surfaces; in addition to which he dispenses with several manipulatory processes hitherto essentially requisite.

Up to this time the yarn could not be printed in the hank, as a single imprinting block only has been in use; therefore it has always been necessary to put the hanks of yarn into another shape, by means of the processes of reeling and winding, &c.

Fig. 1 is a plan of the new apparatus, showing the face of the lower block, the top one being removed. Fig. 2 is a corresponding side elevation, exhibiting the two blocks in their position for imprinting a hank or hanks of yarn. A A, Is the sole of the lower block, carrying four short guide pillars, B B, of cast-iron, bolted down to the sole. C, Is the lower block, notched out at its four corners to fit to the inner angles of the guide pillars.

Fig. 1.

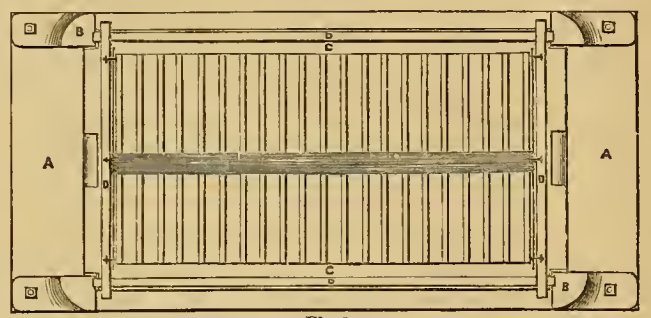
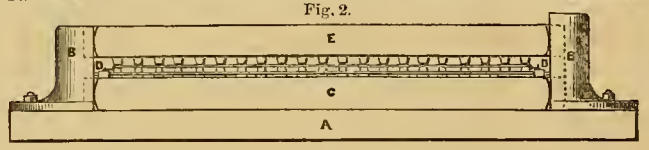


Fig. 2.



1-12th.

In proceeding to print yarn by this apparatus, the lower block, C, is first supplied with colour in the ordinary manner of block printing for calico; it is then placed on the sole, A, between the guide pillars. A light wooden frame, consisting of four thin pieces, D D, is made use of for carrying the yarn to be printed. The two ends of the frame are morticed, so as to be adjustable upon the longitudinal bars, to suit the varying length of the hanks, which are stretched over their wires, carried by the end bars. This frame, with the yarn stretched over it, is then placed as shown in the plan, with the yarn resting upon the coloured faces of the block in the manner that we have represented a few threads.

The upper block, E, is then coloured, and is placed with its grooved face downwards upon the yarn, which is thus compressed between the coloured surfaces, as in fig. 2. By the adoption of a duplex surface, a much greater thickness of yarn can be properly coloured at one impression, than when a single block only is applied on the upper side of the yarn.

The parts of the design which are new, are the whole of the parts as arranged to print yarn in the hank by duplex surfaces.

REVIEWS OF NEW BOOKS.

A Rudimentary Treatise on the Steam-Engine, for the use of Beginners. By Dr. Lardner. London: Weale. 1848. Pp. 130. Woodcuts.

It is long since we have numbered any of Dr. Larduer's literary productions in our review catalogue, and it is pleasant now to meet him as a labourer in the cause of the dissemination of simplified practical knowledge, through the pages of Mr. Weale's admirable "rudimentary treatises." The present treatise stands No. 11 of the second series, which backs the elementary instructions of the first, with a detail of their actual

application by the operative. We are not sure though, that the learned author has made himself sufficiently acquainted with the modern workshop practice for the production of a book like the present, for we find occasional raw matter, which certainly does not relate to English mechanism of a late date. In the first page, where he commences to show "how steam produces mechanical action," he says, "the ends of the cylinder are understood to be closely stopped by lids. One of these lids is cast with the cylinder, and forms, in fact, a part of it; the other is attached to it by screws and nuts, and fitted so exactly that steam cannot escape at the joints." How far the second sentence is correct, our readers will easily judge for themselves.

An example from page 19, *et seq.*, shows the author's acquirements in a better light:—

"HOW STEAM PRODUCES MECHANICAL FORCE BY ITS EXPANSION.

"1. We have seen how a piston is urged from one end to another of a cylinder with a definite force by allowing steam to flow in upon it, and that increased efficacy is given to this by creating a vacuum on the side towards which the piston moves. The steam in this case is supposed to flow from the boiler, and to press the piston forward with a certain uniform force. The piston advances because a fresh portion of steam which enters the cylinder requires more room, to give it which the motion of the piston is necessary.

"When as much steam has entered in this manner as is sufficient to fill the cylinder, then the piston will be driven to the extreme end of it. Now, it is well to observe that in the production of this effect, no quality proper to steam, or which distinguishes steam from any other fluid, is concerned.

"If a liquid (water for example) were made to flow into the cylinder with the same pressure and in the same quantity, it would produce precisely the same effect; in fact, the steam acts thus not because it is an *elastic* fluid, but because it is a *fluid*, and is urged from the boiler with a certain force.

"2. I now come to notice, however, a mode of action in which steam performs what an inelastic fluid could not perform; one, in short, in which it produces a mechanical effect in virtue of that property which steam enjoys in common with air and other gaseous fluids, and in which inelastic fluids, such as water, do not participate.

"3. Let us suppose that the steam flowing into the cylinder acts upon the piston with a certain definite force, as one ton, and continues so to act as long as it enters the cylinder.

"4. Now, let us imagine that when the piston has been thus pushed to the middle of the cylinder, the aperture at which the steam enters is suddenly closed, so as to prevent any fresh supply. The piston will then be no longer pushed forward by any increased quantity of steam coming from the boiler. It will nevertheless be pressed by the elastic force of the steam, just as it would be by the elastic force of air under the same circumstances; it will still be pressed on by a force of one ton, supposing that no adequate resistance obstructs its motion. It will not therefore come to rest, but will continue to advance. As it advances, the steam, expanding into a larger space, will acquire a proportionally diminishing elastic force, and will press on the piston with a force less than a ton, in exactly the same proportion as the space occupied by the steam is greater than half the cylinder. Ultimately, when the piston arrives at the end of the cylinder, the steam, which originally filled half the cylinder, will fill the whole cylinder; and the pressure upon the piston, which was originally a ton, will then be half a ton.

"5. It appears evident then, that while the piston is thus moved through the latter half of the cylinder, it is urged by a continually decreasing force, which begins with a ton, and which ends with half a ton.

"6. If we could calculate the average amount of this moving force, we could at once declare the mechanical effect which is produced through the latter half of the cylinder in virtue of the expansive power of the steam.

"7. At first view it might appear that the average pressure must be a mean between the original pressure of a ton and the final pressure of half a ton, and that such mean would therefore be three quarters of a ton. But such a conclusion would be erroneous.

"8. The method of calculating the exact average of a force decreasing in the manner we have described, requires principles of the higher mathematics, which could not be introduced properly here. By the application of these principles, it appears that the exact average of the varying pressures, in the case we have described, would be 1545 lbs.

"9. The mechanical effect, therefore, obtained in this way from the expansive action of the steam, would be equal to 1545 lbs. driven through a space equal to half the length of the cylinder. It appears, then, that nearly 75 per cent. has been added to the original mechanical effieacy of the steam by this expedient.

"10. It may be asked whether there be any limit to the application of this principle. It is known that other fluids, having the same natural properties as steam, are capable of expansion indefinitely, and it might at first be imagined that there is no limit to the augmentation of the mechanical force which might thus be obtained from steam; but practical considerations show that there are not only limits, but comparatively narrow ones to its application.

"11. It will be observed that the piston, which is urged by the force of expansive steam, is acted upon by a continually diminishing power of impulsion. When the pressure of the steam becomes by expansion less than the load which such piston drives through the intervention of machinery, including the natural resistance of the machinery itself, then it is clear that the moving power will cease to be efficacious, and that the piston must come to rest.

"12. The inertia of the machinery may continue the motion somewhat longer than the moment at which an equilibrium takes place between the resistance of the load and the pressure on the piston, but this effect must soon expire.

"13. The expedient by which the expansive principle may be most conveniently extended is to use, in the commencement, steam of high pressure and great density; such steam may allow of considerable expansion before it loses so much of its force as to be reduced to an equilibrium with the resistance to the piston.

"14. In all cases the expansive principle evidently involves a continual variation in the impelling power of the piston.

"Now it seldom happens that there is any similar variation in the resistance which the piston is required to overcome; and in that case an irregularity of action would ensue. In the commencement, the energy of the impelling force being greater than the resistance, an accelerated motion would be produced, and towards the end, the impelling force becoming less than the resistance, a retarded motion would be the effect. A great variety of contrivances have been suggested by mechanical inventors to equalize this varying action.

"15. The most common and the most beautiful of which is the *fly-wheel*. This is a heavy wheel of metal, well centred, and turning upon its axle with but little friction, so that the force necessary to keep it in uniform motion is inconsiderable. The varying action of the piston is transmitted to this wheel. When the impulsive force is greater than the resistance of the load, the surplus is imparted to the wheel, to which it gives a slight increase of speed. Owing to the great mass of matter in the wheel, an increase of speed which is scarcely sensible absorbs an immense amount of moving force. When the impulsion of the piston by the expansion of the steam becomes less than the resistance, then the momentum of the wheel acts upon the load, and that portion of surplus force which was previously imparted to it is given back, and the wheel assists, as it were, the piston in moving the load when the latter becomes enfeebled by the extreme expansion of the steam.

"16. The fly-wheel is thus, as it were, a magazine of force, which gives and takes according to the exigencies of the machinery. When the moving force is in excess, the fly-wheel absorbs the surplus; when the moving force is deficient, the fly-wheel gives back what it absorbed.

"17. Cases occur, however, in the arts, in which the resistance to be overcome by the piston is of a gradually decreasing nature. In such cases, the expansive action of the steam, being also gradually decreasing, may be kept in equilibrio with the work without the intervention of the equalizing action of the fly. Thus, if the piston work a pump by which a column of water is raised, which column flows off at the top, the length of the column, and therefore its weight, is greatest when the buckets of the pump begin to ascend, and least when they arrive at the summit of their play. The weight in the buckets is in this case of continually decreasing amount, like the decreasing force of expanding steam.

"18. But in most cases some equalizing contrivance is necessary where the expansive principle is extensively used, and where anything approaching to uniform action is necessary.

"19. The expansive action of steam is applied in steam-engines in various ways, but by far the most usual is that which we have described in the above illustration, by cutting off the supply of steam at some point before the completion of the stroke. In some cases it is cut off at half-stroke, in some at one-third, and in some at much smaller fractions of the entire stroke."

A sectional elevation of a 60-horse condensing engine, made by Mr. Fairbairn, does duty as a frontispiece, and several excellent cuts of water-guages, mercurial guages, and the details of a low-pressure waggon-boiler, are given in the latter part of the book. The illustration of the last-mentioned article might have been well dispensed with, to make way for information upon boilers as they are now constructed.

In so far as the author has kept within the bounds which he assigned to himself, in his earlier works on the same subjects, we can add our testimony to the elegant simplicity of his composition; but whenever he oversteps this, he only exhibits the extreme difference which exists between modern and antique engineering.

EVERY MAN HIS OWN HOUSE-PAINTER AND COLOURMAN. By T. H. Vanherman, Artist. 8vo. pp. 124. London: Hebert, 88 Cheapside.

The main feature of this useful volume is a description of the author's "Aromatic Paint," and "Impenetrable or Anti-Corrosive Paint," both of which are formed without the assistance of the deleterious white-lead as a basis, and are devoid of the nauseous effluvium proceeding from all paints as usually made. For out-door work, strict economisers have long striven to substitute coal-tar, and other cheap substances, for the costly materials used by the legitimate painter; but all such attempts have so far resulted in complete failure, for the protection afforded by their factitious pigments is slight indeed. White-lead, again, often gives way to the action of the atmosphere, and may be brushed off with ease after standing a few months in an exposed situation. In all the preparations given by Mr. Vanherman, white-lead forms only a secondary item, and in the bulk of colours it is entirely omitted.

The book is divided into seven sections: the two first treat of the two qualities of paint which we have just mentioned, and the remaining ones are respectively devoted to "Miscellaneous Preparations," "Graining Woods and Marbles," "Oils in General," "Varnishes and Varnishing," and "House Paints." The aromatic paint is so manufactured as to dry in a very short time; and for this reason alone the improvement is worth testing. Mr. Vanherman has performed his literary task in a plain, clear, and succinct manner; and parties who wish to investigate the secrets of painting, may advantageously consult the numerous receipts he has here given.

TREDGOLD ON THE STEAM-ENGINE. Parts II. and III. for Oct. and Nov. London: Weale.

Mr. Sewell's paper on the Management of the Locomotive Engine is continued in the second and third parts of this work. The most minute directions are given in the sections relating to locomotive management: they have apparently been culled from the best examples of well-conducted lines now in operation. Several useful tables of the tractive power of locomotives, the resistance per ton upon different gradients, revolutions of the driving-wheel for different speeds, and the comparative bulk of water and steam at various pressures, are added to the engineer's instructions; together with calculations of the consumption of coke under given circumstances.

A short account of the Express Engine of Mr. Samuel completes Part III. The plates are—an elevation of a goods-engine on the Great Western Railway; a longitudinal section of an outside cylinder tank engine, as made by Messrs. Sharp for the Manchester and Birmingham Railway; diagrams of resistances per ton of the train, and per ton of the engines, with various loads, and at different velocities; and three sheets of the Express Engine. The plates are excellently engraved by Mr. Lowry. Of the letter-press we shall know more as the work proceeds.

THEORETICAL AND PRACTICAL MECHANICS, DESIGNED PRINCIPALLY FOR PRACTICAL MEN. By JAMES HANN, A.I.C.E. London: Weale.

For some years last past, there has existed a latent tendency towards the production of more ostensibly practical works than were formerly published, or, indeed, deemed necessary. The domain of practice (we allude to engineering practice) has latterly been very much extended, and has suddenly acquired a degree of importance much beyond anything that was reasonably anticipated, before the late forward movement in the engineering world. And as the practice extended, an increasing necessity was felt for published works, bearing directly on the objects to which the attention of engineers was directed, whence sprung up an abundant efflorescence of Guides, Hand-books, and Monitors, in various departments. of various merit. The distinction, however, between purely theoretical works and purely practical works, still remains as an evidence of the hitherto unsuccessful attempts usefully to combine the two classes of works in one. The history of mechanics has shown, that mechanics, as an art, is generally independent for its advancement on mechanics as a science; and all that can be properly claimed for the latter as usefully antecedent, and preparatory to the former, is principally to be confined to the development of a few elementary principles. The error committed by the generality of our writers on mechanics, lies in their confining themselves too exclusively to the elaborate elucidations of principles, as if the path from "principle" to "practice" were short and sure, and as if it were impossible to have too much of the good thing. In whatever way it is to be explained, whether by supposing, with Willis, that the construction of a machine—that is, practice—may be reduced to a problem of mere motion, to be resolved by science; or, with Bourne, that the class from whom mechanical writers are, for the most part, derived, do not possess any practical acquaintance with their subjects; or, further, that the dogmatic spirit in which "principles" are commonly enunciated, has silenced the last pretending votaries of the practical arts; certain it is, that the treatises on mechanical principles have always far exceeded in numerical force the decidedly practical works.

The book before us, by Mr. Hann, of King's College, London, while it indicates a constant endeavour to reduce the principles of mechanics to ordinary practice, indicates also the absence of those qualifications which are absolutely necessary for the production of a useful book. While he has succeeded in presenting several subjects under new aspects, and in condensing, in some instances, the ordinary modes of investigation, it cannot be concealed, that "practical men" will not be one whit the better for the work; and for this reason, that it is written in the language of science, with all its formalities, abstractions, and complex formulas. The simplest demonstrations, and those the most proper for the practical man, are confounded in his mind with empirical formulas or arbitrary data, and if he do not give up the subject, he at least derives no benefit from it. The main characteristic of such a work ought to have been, that it should exclude every too intricate calculation, and offer, instead, short and clear explanations. It is evident, that to advance the art of construction and ordinary mechanics, a method different from what is intelligible only to those who are versed in the higher mathematics must be employed. Those who would assist the advancement of industry, must place at its service the simplest principles of science, in a language stripped of every conventional form; thereby they would extend, and, as much as possible, popularize the practice of industry.

We must not, however, part with Mr. Hann on such equivocal terms. While we deem his success to be short of the high aim he proposed to himself, we are indebted to him for some valuable investigations. His remarks on the difference between finite and impulsive force should find a place here, as they bear upon and illustrate the subject of impact, formerly discussed in our pages (*ante*, p. 3):—

"A *finite* force is a force that acts for a *finite* time, such as the force of gravity. An *impulsive* force is a force which acts during an extremely small time, and is so called, because the forces that take place in any impulse, or impact, always act in an extremely small time. The time which elapses between the beginning and the end of impact is always extremely small—so small, that it neither has been nor can be measured. In consequence of this, all that we can find out in the case of impact is, the whole effect produced by the impact. We cannot find how the body is moved during the impact, because the time is so short that it is impossible to appreciate the variation of motion. The contrary is the case with finite forces. When we are concerned with finite forces, it is always an object to find out how the body is moving at any time, while it is under the action of a finite force. This constitutes the great distinction between problems which relate to finite and impulsive forces. There is also another important difference between them, which is this: in the case of finite forces, the body moves over a finite space during the action of the force, and therefore its position is sensibly changed by the force: but in the case of impulsive forces, the action of the forces is finished before the position of the bodies has been sensibly altered."

Finally, we recommend the work as an excellent study for young engineers, previous to their emerging into business. Youth is emphatically the period for mental improvement; when once involved in business, business then becomes the great study of life.

THE ARCHITECT, BUILDER, AND CONTRACTOR'S POCKET-BOOK OF PRICES FOR 1849. Plates. Pp. 354. London: Weale.

The architect, builder, and contractor, and their brethren, have this year found an advocate in Mr. Weale, who has stored up for them, in pocket-book fashion, a variety of practical information bearing upon their professional avocations.

The book is got up in Mr. Weale's usual substantial style, and contains, in addition to the general diaries and memorandum pages, which are found in his "Engineer and Contractor's Pocket-Book," a vast quantity of condensed information for architects, carpenters, bricklayers, masons, plasterers, and the great mass of tradesmen who join their endeavours for the production of buildings. The great point of the volume is the classified list of prices, deduced from the official lists of the Board of Works, which have been adopted by the higher class of architects as a basis for all contracts. Smith's, founder's, and ironmonger's prices are also appended; and these tables are characterized by great minuteness, very different to the rough notes often given in architectural works of higher pretensions.

In the "Notitia Architectonia" of the second part, is given a series of remarkably well-written articles upon lime, concrete, stone, wood, sewers, and cast-iron girders, finishing with an abridgment of the act for promoting the public health.

We have read this portion of the book with great pleasure, and when time and space permits, we may transfer some examples of it to our own pages.

TWENTIETH ANNUAL REPORT OF THE PRESTON INSTITUTION FOR THE DIFFUSION OF KNOWLEDGE. 1848.

This society, in common with others of its class, has felt the pinching effects of the late commercial stagnation. The average number of members on the books for the year is 557, being something more that 50 less than the number of last year. The library now contains 4140 volumes, two hundred and forty-six of which have been added by purchase and donations during the past year. Eighteen lectures have been delivered during this period; and of these, it is a subject for honourable remark, in connection with the more active members and friends of the institution, that all but two have been delivered "without money and without price" in return. To show what subjects have engaged the attention of the members, we append the heads of the series:—"Physiology and the Prevention of Disease," by Mr. Gracy; "Nature and Objects of Poetry," by Mr. Higgins; "Chemistry, in application to Agriculture and Physiology," by Mr. Hall; "Objects to be aimed at in Training the Youthful Mind," by Mr. Peet: "Ancient History of Great Britain," by Mr. Lloyd; "An Exposition of the History of Painting, Sculpture, and Architecture in England, from the Anglo-Saxon period," by Mr. Burton; "The Recent Discovery of an Unknown Planet," by Mr. Holden; "Chemical Affinity," by Mr. E. Brown; "Chemical Agencies of Light and Heat," by Mr. J. Browne; Readings and Recitations, and an Essay "On the Laws of Gravitation, and how they affect the Universe," by Mr. Motler; "On the Evidence of Design, evinced by a glance at the various peculiarities of Structure in some of the Lower Animals," by Mr. Howitt; and "On Agriculture," by Mr. Veevers.

The new building, for the purposes of the institution, commenced some time ago, has been at a stand-still for a considerable period; but by a munificent gift from Mr. Birchall, the late mayor, the committee have been enabled to take active steps for its completion.

We hope to be able, at an early period, to chronicle a more prosperous condition of this valuable association. A library of more than 4000 volumes, many of them rare and costly works, relating to all branches of science, is certainly deserving of the warm support of the scientific and mercantile residents in a town so energetic as Preston.

CORRESPONDENCE.

THE RELATIVE DENSITY OF WATER, STEAM, AND AIR.

AN ILLUSTRATION OF THE PROGRESS OF SCIENCE.

These are matters which I am at liberty to assume have been long since settled to the satisfaction both of the mechanic and philosopher, especially as scarcely a newspaper or novel can be taken up, free from some reference to the rare scientific attainments of the present day.

This steam-going age, both by land and water, has given a currency to the notion that science must have taken a long stride, or otherwise these wonderous ways of travelling would still be slumbering in dark-

ness. The subject standing at the head hereof is intimately connected with both methods of progression, and my present purpose is to display our present ignorance thereof.

When a philosopher differs with himself, and some do—when he tells one tale in one page, and another in the next—I consider him as fair game, and that his errors deserve to be hunted down, albeit the requital, judging of the future by the past, is rather to be expected in thumps than in thanks.

In the Dictionary of Chemistry by Dr. Ure, 4th edition, at page 279, I read "that aqueous vapour of an elastic force, balancing the atmospheric pressure, has a specific gravity compared to air of 10 to 16."

At page 287, I find that "a volume of water at 40°," *(its maximum density or thereabout,)* "forms 1694 volumes of steam at 212°." At page 122, the specific gravity of water to air is as 827 to 1. Whence $\frac{1694}{827} = 2{,}048$ should be the relative density of air to steam, when the latter is 1. Others, as I think, have taken the density 840 to 1; and one philosopher has found it to be 914 to 1, near the surface of the earth, and the air at a medium temperature and density.

How much soever a philosopher may disagree with himself or with others, it is not so in nature's ordinances. Surely, then, I have shown ample cause for disputing our scientific acquirements, and also for having elsewhere* attempted an hypothesis, independently of all experiment, connecting together gravity, temperature, pressure, and dilatation of steam, according to given formula;—and in reference thereto, if the density of water to air may be taken at 843·75, (instead of 840,) and if the dilatation of water at 40°, when vaporized, may be taken at 1687·5 (instead of 1694); the density of air to steam will be exactly as 2 to 1, when the mercury in the barometer is at 30 inches, and the steam compressed with 30 inches of mercury,—being a proof that the densities of the respective matters is either as 10 to 20, or very nearly so, instead of being as 10 to 16.

Are we then not at liberty to suspect that the progress of science has not kept pace with its estimation in the eye of the public, and that our present modes of travelling are merely the result of experiment? I am not prepared to show, for I have never inspected a locomotive engine, what may be its merit or otherwise; but nevertheless I am prepared to say, on the showing both of mathematicians and engineers, that one-half of the power of steam generated, or thereabout, is sacrificed both in railway travelling and in navigation by steam.

JOHN CURR.

Islington, Dec. 6, 1848.

ON HYDROSTATIC PRESSURE AS A SUBSTITUTE FOR GENERAL MANUAL LABOUR.

Several years ago, a Mr. Simcox invented a machine for the employment of hydrostatic pressure as a prime mover, the head of water acting upon the piston of an open-topped cylinder, somewhat like that of the old atmospheric steam-engine. In this machine, a vital defect was soon apparent. The water which flowed into the cylinder beneath the piston, with the full force due to its head or elevation of supply, could only escape by its own gravity, aided, of course, by the atmospheric pressure upon the piston's surface. Lately, I believe, a new engine on the same principle has made its appearance; it is said to have an improved valvular arrangement, so that the water flows in and out of the cylinder with equal ease. Can you favour the readers of the Practical Mechanic's Journal with any further information on the construction of this machine?

It appears to me, now that we have in most towns (soon I hope in all) a supply of labouring force, stored up in the most available manner in our elevated water reservoirs, such machines would be found extremely valuable for parties who require a small occasional power. For example, the operations of coffee grinding, coffee roasting, ornamental turning, and the movements of agricultural machinery, might be economically effected upon this principle. And when we consider that the water so employed to produce these effects, might be re-applied for culinary and other useful purposes, the value of the application becomes evident. We know the effect of "Barker's Mill," with its patented improvement by Whitelaw & Stirrat; also somewhat similar inventions in Belgium, by M. Fourneyron, called by him "Turbines Hydrauliques,"—and the question to which I wish to draw the attention of your young correspondents is simply this:—What is the best mode of employing water-pipe pressure in the way I have hinted, *i.e.* for a small intermittent power?

WM. TAYLOR.

Preston, Dec. 11, 1848.

[The letter below refers to a model of the identical invention to which Mr. Taylor alludes. Mr. Armstrong has since kindly offered to furnish us with a drawing, and some particulars of it. In addition to several hydrostatic cranes at Newcastle and Liverpool, Mr. Armstrong has just erected one on the Broomielaw quay here, to be worked by the water of the Gorbals Works, lately described and illustrated in this journal. These cranes, which are upon the same principle as the pressure engine mentioned by a "constant reader," answer their purpose extremely well. The Glasgow one has been tested by a load of 11 tons, which it elevated and turned round with great precision, and with a small expenditure of water. The application of water-power in the way Mr. Taylor mentions, is a favourite project of our own. We cannot too highly recommend it to the attention of our readers.—ED.]

* See "Physical Properties of Steam."

NEW HYDROSTATIC PRESSURE ENGINE.

Having lately noticed in several papers a description of a hydrostatic engine, I may inform you that an engine of that description has been in operation, driving the machinery since the month of April, at the Polytechnic exhibition, which has been held at Newcastle. It is the invention of W. G. Armstrong, Esq., the inventor of the hydrostatic crane. The engine, while at the exhibition, worked at a velocity of about 60 revolutions per minute, and I have on some occasions seen it work up to 120. When set away with the full pressure, it flew like a locomotive, and worked so free that you could not hear it when the lathes and other machines were in motion—to use the familiar expression, "it wrought like oil."

A description of the engine would be a subject of general interest. It has been a source of great attraction to the exhibition.

A CONSTANT READER.

Newcastle, Nov., 1848.

ON THE EFFECT OF DIMINISHED ATMOSPHERIC PRESSURE UPON CONDENSING STEAM-ENGINES.

In your last number, page 214, Mr. W. Taylor of Preston, asks—"In what ratio, or to what amount, the effect is produced," relative to engines being placed 30 feet or 1000 feet above the level of the sea?

As a practical solution to this question, we may consider the atmosphere to be of one uniform density; and, therefore, the difference of pressure will be simply proportional to the difference of the altitude. Thus, taking a cubic foot of air to weigh 1·21 oz., a column of 144 feet high, and 1 inch area, will be the same weight. Therefore we have

$$\text{As } 144 : 1{\cdot}21 \text{ oz.} :: \overline{1000 - 30} : \frac{970 \times 1{\cdot}21}{144} = 8{\cdot}15 \text{ ounces, say } 8\tfrac{1}{2} \text{ ounces}$$

less of atmospheric pressure for every 1000 feet high.

W. K.

Blackburn, Dec. 11, 1848.

CERTAIN PREVENTION OF EXPLOSIONS IN STEAM-ENGINES.

It is impossible for the force of elastic steam to produce the breaking of engines, and rending of boilers, that so frequently occur: they are the work of the explosive principle when disengaged from its combination with steam. Similar in its effects to lightning, it is identical with electricity in its distinctive properties. Its velocities are in effect unlimited. It is devoid of weight, and not subject to the laws of gravitation, which are inherent in all matter that has weight; and it is hence evident that it may be conveyed away by similar conductors.

It is absolutely certain that the explosive principle is disengaged from steam as it is let into the cavity of the nozzle, or valve-chamber, on the opening of the steam-valve; the pressure that kept them combined is then in great part taken off, until the cavity is filled with steam. There is no proper escape of the explosive element from the nozzle, which is heated, and in effect insulated, and the accumulation is highly dangerous; but it may be safely carried off by proper conductors: those most convenient are small copper tubes.

One end of a tube of proper length is to be terminated in the best manner for the diffusion of the electric fluid; the other end to enter the cavity of the nozzle, and have over its orifice a slight valve, kept by a spring a little open, to allow the explosive element to pass off by the tubular conductor, the valve to close by the force of steam as the cavity becomes filled therewith. The conductors of a condensing engine should be carried high enough above the water in which they terminate to preserve the vacuum.

The security from explosions and breaking of engines must be complete, the cost and trouble only nominal.

JOHN WILDER.

New York.

WHO FIRST PROPOSED LOCOMOTIVES WITH INSIDE CYLINDERS AND OUTSIDE VALVE-GEARING AND FEED-PUMPS?

Having observed in the November part of your Journal, an article, under the title "Recent Patent," ascribing to Messrs. M'Conochie and Clande, of Liverpool, the merit of the discovery of that improvement in the construction of locomotive engines, effected by the arrangement of "inside cylinders and outside valve-gearing and feed-pumps," I am convinced that, whatever "inventive energy" may belong to or characterize the patentees, no portion of the honour of this improvement can possibly be theirs. The palm must be borne off by another and more extensively known firm, as the following facts will prove:—Engines, with ontside pumps, have been working on the York and North Midland Railway upwards of *two years*; and there is now on the York, Newcastle, and Berwick Railway, a locomotive (No. 185), constructed by Messrs. Robert Stephenson and Co. of Newcastle-on-Tyne, with the very combination of "inside cylinders and outside valve-gearing," which Messrs. M'Conochie and Claude have patented. This engine was ordered in 1846, and the arrangement fixed upon early in 1847, and delivered on the company's line on the 3rd October ultimo, since which period she has been regularly running.

I may also add, that on Saturday the 9th curt. Messrs. R. S. and Co. tried another engine of the same construction as No. 185; and have in their works, in the course of erection, several others on the same principle.

PHILAREDES.

29 *Ellison Street, Gateshead, Dec.* 13, 1848.

[We do not think either party can well claim the original idea of "inside cylinders, with outside valve-gearing and pumps;" but Messrs. M'Conochie and Clande have, at least, some merit for their modification, and practical working out, of the plan.—ED. P. M. J.]

ON THE FORMATION OF COAL.

The evidence now adduced confirmatory of the origin of coal from vegetable matter appears to be satisfactory, although many who are conversant with the doctrines relating to this subject differ widely as to whether it is formed from wood or other vegetable prodnctions. The former idea was prevalent for a time, and seemed so far consistent, until the wood had to be drifted from its original situation by the supporters of that doctrine, in order to enable them to overcome certain objections; when, forgetting that water is impartial in its depositions, as is amply corroborated by boulders, &c., the regularity of the seams, as regards their lie, thickness, and exclusion of foreign matter therefrom, preponderated in favour of the latter. Water, nevertheless, is subservient in the removal of materials from one place to another, more especially those whose specific gravity rates under 1. But whoever looks on the fallen tree, and afterwards directs his attention to the moss in course of extension—however regular the strata immediately above or below the coal may be—will, I think, be induced to say that the agency of water in the formation of coal consists chiefly in entombing, not in transporting the article of which it is composed.

Your correspondent in a recent article, signed "G. R. B.," is anxious, I perceive, to prove the vegetable origin of coal. Whether or not he has annihilated any of the presnmed encumbrances by his six month days and six month nights, with a good fire-clay soil and heat, I will not at present remark npon. Meantime I may state, that coal is not always situated on fire-clay; for we find the Pyotshaw coal, in many places throughout the Lanarkshire basin, placed immediately on the main coal, and only separated by a parting often scarcely perceptible. The main coal in many places rests on a sandstone post, and the roof is also generally sandstone. In Ayrshire there are also many instances contradictory of the above assertion; but it is unnecessary to ennmerate them. In the Bartonholm coal-field, however, some parts of the seams are incumbent on trap rock. Your correspondent introdnces also wood and iron filings in acconnting for the formation of ironstone. That this mineral is of vegetable origin is also generally admitted; and that the whole seams of ironstone, however deep the cavity may be, once reflected, or perhaps absorbed by the sun's rays, is apparent from the living monuments that have been extracted from the seams already wrought. To follow yonr correspondent's reasoning as to the object in view, would, I am afraid, lead to a false conclusion, as nature also performs chemical operations, changing wood into stone, and in not a few instances have human bodies been petrified into sandstone, and their form preserved in this state.

Laying aside this critical chemical mode of investigation, ironstone, especially the black band, is often displaced, or rather the place where it should be is occupied by coal—not only free coal, but gas coal—I would ask your correspondent, therefore, if, by placing coal under a certain kind of strata, or a line, say the matter that originally overlapped the ironstone, combined with the action of water, a change in the coal would be induced? Or, to be more explicit, I am inclined to believe that ironstone of the black band description is formed from coal (fire coal first, then gas coal, afterwards ironstone), and request his objections. At the same time, suppose the mosses in Lanarkshire to be after this time covered and converted into coal, what seam or seams would they form, or where would they stand in the section? Knowing that the sea is changing its position, how long will it take to perform a revolution—or at what rate is it moving? G. S.

Dec. 18, 1848.

THE RESISTANCE TO RAILWAY TRAINS.

In your Journal for the last two months, I have noticed a considerable portion of their space to be devoted to the letters of a Mr. Curr, who appears to delight in using the works of others, whilst he picks out everything which he fancies to be a flaw, to be held up to ridicule. Last month he wrote on girders for railway bridges; this month, on the resistance to railway trains, and, in addition, has worked up an immense quantity of words and decimals, because your really clever correspondent, "H. R.," happened to word his communication in a manner which did not please him. I am glad to see that "H. R." has forced him to a point.

I confess that I do not see at what Mr. Curr can be aiming, in picking out any little discrepancies which he can detect in the condensed statements of experimeuts, &c., to be found in pocket-books and periodicals, and thus bringing charges of stupidity against all parties, whilst it is evident that, in works of this kind, no man can devote his whole attention to one single subject.

The subject of the resistance to railway trains, is one of the most difficult with which engineers have to deal; and had Mr. Curr been present at the meetings of the Institute of Civil Engineers last session, he would probably not have written what he has upon this subject. The question is not to be decided upon insufficient data; it will not do, therefore, to pick up a solitary experiment with an engine and train, and knock off one-third for the weight of the wheels and axles, for every one who is at all acquainted with locomotives knows, that out of a 34-ton engine and tender there is nothing like $11\frac{1}{2}$ tons of wheels and axles; neither will it do to jump at the area opposed to the wind, in the way he has done—to leave out of the question the state of the rails—or to neglect the side-wind, which Mr. Gooch has proved to have a considerable effect, from its driving all the flanges of the wheels on the opposite side of the carriage into close contact with the inside edge of the rails; and any calculation based on formula, in which these numerous causes of retardation are neglected, cannot be worth a straw.

As to the pressure on the pistou, it is no easy task to take off indicator diagrams from the cylinder of a locomotive, going 43 miles an hour. In the late experiments on this subject on the Great Western Railway, it was found to be a work of much difficulty and danger, from the position in which the party operating had to place himself. H. W.

Paddington, Dec. 4, 1848.

PHENOMENON ATTENDING THE DISCHARGE OF HIGH-PRESSURE STEAM.

The phenomenon which Mr. Vincent Bird has observed on lifting the safety-valve, is probably caused by a current of electricity passing from the steam to the metallic valve. If a conductor is brought into the vicinity of a cylinder of glass, which has been acted upon by friction, a lambent light will be seen to pass between the two. Steam, like excited glass, in passing from an orifice, is in a highly etoilé, or positively electric state, whilst the boiler is pinceau, or negative. If Mr. Bird will take the trouble to insulate himself, holding a conducting-rod in the discharge of steam, he will find that an electric spark will result from touching another person standing on the ground.

It has not yet been decided whether the electricity of steam is caused by evaporation, or by a chemical action. However, it is a fact beyond all doubt, that electricity is given off in immense quantities during evaporation. Whether I am right or wrong in my presumption, as to the origin of the light observed by your correspondent, he is, at any rate, entitled to great credit for bringing the matter forward for the investigation of the public. R. SMITH.

Blackford, Dec. 1, 1848.

ON DRIVING THE SCREW-PROPELLER DIRECT.

The subject of driving the screw direct, has occupied the attention of most of our eminent engineers, who have aimed at simplicity in marine works, and to this end the direct-action engine has been very generally adopted. But however much simplicity and compactness are to be desired, I am of opinion that they must be in some degree sacrificed, when notable advantages of another kind are to be obtained. If we consider the weight of the principal moving parts of a large marine engine, and that their weight is to be forced to and fro, from 70 to 100 times per minute, it is easy to see what does actually occur in the irregular movements of the vessel. From my own observations on this subject, I am convinced, that it is expedient in large engines to drive the screw through the agency of gearing; the pistons to have a long stroke, and to move at a moderate velocity.

I admire a direct-acting engine applied to the screw, for its simplicity; but I admire an engine with good gearing, for its economy. There is another point upon which I have not touched—that is, the difficulty and danger of driving the air-pump at a high velocity; and I am pretty confident that the principle of direct action will shortly be abandoned in favour of gearing. W. E. D.

London, Dec. 1848.

[It is quite true that we have no good examples of screw direct-action on a large scale; but if our correspondent will take the trouble to turn to the experiments and practical results of Mr. Grantham's auxiliary steam-vessels, he will find that a very good speed has been obtained, without subjecting the engines and vessel to the injurious effects of quick strokes. With all deference to "W. E. D.," we think that the direct-action principle will be carried into practice still further, to the abandonment of the heavy gearing, which is costly, cumberous, and a very great nuisance in working.—Ed P. M. J.]

ANSWER TO A PRACTICAL QUESTION.

If you consider the following a correct solution of the "Practical Question" in your last number (page 184), you will oblige by giving it insertion in your next.

Let x and y denote the respective diameters of the first and last coil of rope in inches, on their respective points of suspension.

Then $\frac{y-x}{2}$ = number of coils. And $\frac{y-x}{2} \times \frac{y+x}{2} \times 3{\cdot}1416 =$ length of rope. That is, $\cdot 7854\ (y^2 - x^2) = 12\,l$, or $y^2 = \frac{12\,l}{\cdot 7854} + x^2$.

Now, the resistance to the engine will be measured by the *difference of the products*, arising from multiplying the respective diameters by the respective weights, on the ascending and descending ropes. Thus, $(p\,l + b + c)\,x - b\,y =$ resistance with full basket at the bottom of the pit, and $(b + c)\,y - (p\,l + b)\,x =$ resistance with full basket at top; which, per question, are equal to each other. Hence the equation, $(2\,p\,l + 2\,b + c)\,x = (2\,b + c)\,y$; or, $y^2 = \left(\frac{2\,p\,l + 2\,b + c}{2\,b + c}\right) 2x^2$.

Consequently, from the previous value of y^2 we have $\left(\frac{2\,p\,l + 2\,b + c}{2\,b + c}\right) 2x^2$, $= \frac{12\,l}{7854} + x^2$, whence we obtain $x = \sqrt{\frac{12\,l}{7854}\left\{\left(\frac{2\,p\,l + 2\,b + c}{2\,b + c}\right) 2 - 1\right\}}$

= diameter of the first coil; and this—1, gives the diameter of the drum required.

Arithmetically:—Divide the sum of twice the weight of the rope, twice the basket and weight of coal, by the sum of twice the weight of the basket and weight of coal; square the quotient, subtract 1, multiply the remainder by 7854, and the product is the *divisor;* by which divide the depth of the pit in inches, then extract the square root, and you get the diameter of the first coil, which, minus 1, gives the diameter of the drum required. W. K.

Blackburn, November 20, 1848.

VULCANIZED INDIA-RUBBER PACKING FOR STUFFING-BOXES.

I have for some time thought that vulcanized caoutchouc would answer as an excellent and durable packing, for all kinds of stuffing-boxes: it might be put in, with very little trouble, in rings of the required depth, and would be as durable as Mr. Hunt's metallic packing given in your last part.

Aberdeen, Nov. 15, 1848. W. J.

[If our correspondent tests the frictional effect of this material, we think he will find that it is inapplicable for the purpose.—Ed. P. M. J.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF MECHANICAL ENGINEERS.

Birmingham, October 25.

J. E. M'Connell, Esq. Vice-President, in the Chair.

This, the first meeting of the members of this institution since the death of their lamented President, was opened by Mr. Scott Russell's able notice of his life and character, which paper formed our passing extract from the proceedings, in last month. As the highest tribute which the members could pay to the memory of their leader, they have unanimously elected his son to the presidentship in his stead; a step which, we are certain, every one will agree in thinking to be reflective of the greatest honour on both sides.

The professional business of the meeting commenced by the Secretary, who read a paper by Mr. John Jones of Bristol, "On the adaptation of the Cambrian Engine to locomotive purposes.*

Some discussion was raised by this paper, in the course of which, Mr. Slate stated the difference between the "Cambrian" and the ordinary locomotive, consisted in the fact, that the former had the advantage of having the principal weight between the wheels. In other respects it much resembled the engine lately built by Messrs. Wilson of Leeds; the chief difference being, that in the latter there was a strain on the bearing of the central shaft, which he did not find in the former; otherwise the balancing of the engine was exactly the same.†

This paper was followed by a long discussion, resulting in a general opinion of the members, that although there were many ingenious features in the Cambrian engine, as thus applied for locomotive purposes, still the ordinary straight cylinder was to be preferred for correct action and durability. This detail refers almost entirely to the illustrative drawing, without which it is unintelligible.

Mr. Cowper then read the following extracts from Mr. Wicksteed's printed report on Brockendon's application of Vulcanized India Rubber to pipe joints.

On the 22d of May, experiments were tried upon the new rings and filletted pipes:—

Exp. 5th.—4-inch joint, spigot *without* the upper fillet, stood 658 feet pressure, and gave way under 733 feet.

6th.—4-inch spigot *with* it, stood 1241 feet pressure, and was not tried farther.

7th.—9-inch, spigot *without* the upper fillet, stood 733 feet, but worked and leaked very slightly from 240 feet pressure and upwards.

8th.—9-inch, spigot *without* the upper fillet, stood 755 feet, leaked as before, and blew out at 945 feet pressure, *after* 4 or 5 strokes of the pump.

9th.—9-inch, spigot *with* upper fillet, stood 1241 feet, at 945 feet, it worked and leaked very slightly, and continued to do so at 1241 feet, but it did not blow out, the belt preventing it.

10th.—12-inch, spigot *without* the upper fillet, stood 733 feet, and at 900 feet, after working the pump for some time, it gave way.

11th.—12-inch, spigot *with* upper fillet, stood 600 feet, the ring was so thick that it could not be made to enter the joint properly, and, when joined, the ring oozed out past the belt, so that no fair trial could be made.

12th.—12-inch, spigot *with* upper fillet, stood 1333 feet, the ring was again too large, and if it had not been kept in by the belt would not have stood the pressure, the ring oozed out all round the joint, but stood the pressure without leakage. After a few strokes of the pump, however, the iron-pipe burst. The pipe was $\frac{9}{16}$ths of an inch thick, but there was an air-bubble flaw in it.

After a variety of experiments tried in the months of April, May, July, and August—some in the presence of Mr. Brockedon and Professor Cowper—the proper thickness of rings and forms of sockets and spigots were determined on, and the following very satisfactory results were arrived at.

13th.—The 12-inch stood a pressure of 600 feet, and at first 900 feet, but after working the pump for a short time it gave way.

14th.—The 4-inch stood a pressure of 1333 feet, without giving way at all.

This result showed that the rings of the 12-inch were too light, and that the 4-inch, although it stood the greatest pressure, appeared to enter the socket too easily; I therefore proposed to increase their weight to 4½ ounces, and 1½ ounce respectively.

Upon July 31st, 1848, the new rings were tried, the 12-inch weighing 4⅔ ounces, the 4-inch 1½ ounce.

15th.—The 12-inch stood a pressure of 900 feet, but after several strokes of the pump at a pressure of 1333 feet, it blew out at a defect in the upper fillet on the casting.

16th.—The 4-inch stood a pressure of 1333 feet without giving way at all.

17th.—The 12-inch stood a pressure of 1333 feet.

Upon the 15th May, the five 4-inch pipes were joined together without fillets on the pipes, and with the rings supplied at that time as hereinbefore described as imperfect. These joints have been exposed to a varying pressure of from 90 to 175 feet to August 21st, being a period of above three months, and they are now perfectly tight, and no change has taken place.

* A brief account of this application will be found at pages 80, and 105, *ante*. Mr. Kintrea having obligingly supplied us with drawings of a locomotive of this construction, we may possibly be able by their means, to illustrate the subject at a future period.

† Mr. Slate is perhaps hardly correct in stating that the balancing action is the same in each engine. The momentum of the piston and shaft is perfectly balanced in the "Cambrian," but this cannot be said to be the case in Mr. Wilson's engine, where the momentum of each piston and connecting-rod, &c. is quite uncbecked. The former has certainly no strain on its central shaft.

The time occupied in these trials has been above five months, and I am now enabled to speak very confidently of the value of the new joints.

It appears that, for a 4-inch joint, the space between the spigot and socket being ¼ of an inch all round, the Vulcanized India Rubber ring should weigh 1½ ounce, and for a 12-inch ring the space between the spigot and socket being the same, viz., ¼th of an inch, the weight of the ring should be 5½ onnces.

The spigot and socket ends of pipes to suit the Vulcanized India Rubber rings should be formed as follows:—The depth of the socket for all pipes up to 12-inch, which is the largest I have experimented upon, should be 3½ inches; the thickness of the joint or space between the ontside of the spigot and inside of the socket, should be ¼ of an inch. There will be no occasion for extra strength in the sockets, as they are not exposed to any blows or to the force of the wedge in making the joint, as in lead or wood joints. The spigot should have a bevelled sqnare head or belt $\frac{5}{16}$ths of an inch thick, and ½ an inch deep, cast on the end, then a clear space of 2½ inches, and another belt of the same dimensions.

I have calculated the weight and cost of 100 rings of various sizes, which will be the number required for 300 yards of pipes, as follows:—

	Weight. lb.	oz.	Per lb.	£	s.	d.
3 inch	7	0	@ 5s.	1	15	0
4	9	6	—	2	6	10½
5	12	5	—	3	1	6¾
6	15	4	—	3	16	3
7	18	3	—	4	10	11¼
8	22	2	—	5	5	7½
9	24	1	—	6	0	3¾
10	27	0	—	6	15	0
11	29	15	—	7	9	8¼
12	32	14	—	8	4	4½

To make a comparison between the cost of the India Rubber joints, and lead or wood joints, I have in the following statement included the *material*, the *labour in making the joint*, and the *excavation*, and *filling in of the trench* only, but including 10 per cent. profit.—

	Lead per yd. run s.	d.	Wood per yd. run s.	d.	Vulcanized India Rubber per yd. run s.	d.
4-inch	0	6 $\frac{6}{10}$ths	0	4 $\frac{6}{10}$ths	0	3 $\frac{3}{10}$ths
12-inch	1	7	0	11	0	9 $\frac{9}{10}$ths
3, 4, 5, 6, 7, 8, 9, 10, 11, 12 in. one yard of each	10	0	6	2	5	2

Taking one yard of each sized pipe, from 3 inches to 12 inches inclusive, and in addition to the above adding the average cost of *carting the pipes to the trench, removing surplus earth, repairing drains, lead pipes, &c., and all other charges and risks, and guarantee for twelve months*, EXCEPTING *the charges of the Commissioners of Roads or Streets for paving, &c.*, the cost will be as follows:—

Lead.	Wood.	India Rubber.	India Rubber cheaper than Lead.	India Rubber cheaper than Wood.
23*s.* 10*d.*	20*s.* 6*d.*	19*s.* 6*d.*	22 ℘ cent.	5 ℘ cent.

Mr. Cowper exhibited and explained a diagram, showing the nature and operation of the joints; and having stated that the cost would not exceed one-half of that of the ordinary lead joints, a member inquired, what would be the comparative durability? He was given to understand that lead would endure for 50 years. —Mr. Fothergill apprehended great difficulty in repairing the joints, without disturbing a great number of adjacent pipes.—Mr. Clift had no doubt they would answer extremely well for street mains, or in straight lines; but doubted with Mr. Fothergill, whether, in the event of an escape of gas, or water, they could be conveniently repaired in angular positions. He conceived that the greater the pressure of water the sounder would the joint be; but the less the pressure the greater the liability to escape.—Mr. Richards spoke to an experience of twelve months of the joints in question. In the month of June he had occasion to relay the town of Worcester with new gas mains,—the vibration of the road having induced leakage to a considerable extent. He accordingly applied to Messrs. Mackintosh for some of these joints, and could speak, in confident terms, to the value of the invention. He first applied them, in the works, to ascertain whether they would sustain the effect of the ammonia and corroding gas; and he had also tried them in the street, and in both cases they were entirely unaffected by the components of the gas, and still remained perfectly tight. He had also applied them in the street mains, and they were decidedly tighter than the old joints. With reference to the expense, it was below one half of the old plans, and there was by no means the difficulty in repairing them which seemed, by some, to be anticipated; for he had recently tested it where there was an inclination of 30 degrees, and by removing half a dozen joints, he was enabled to make the repair desired, which could not have been done in the case of the old ones. In fact, he believed them to be superior to anything else in use, and intended to apply them to gas purposes generally.—Mr. Humphreys said it appeared to him to be a very valuable application; and if they left off the bead in the pipes, which appeared to him perfectly useless, they might incline or angle the pipes to any extent. Mr. Fothergill agreed with the last speaker, that, on the plan proposed, they could incline the pipes to any extent; and the only point to be guarded against was, the fact, that it would require a length of time to ascertain their durability. They could not tell how the frost, or a change of temperature, would influence them; but, otherwise, as far as he could see, the invention was a very valuable one.—Mr. Richards observed, that he had had some of the pipes exposed to all kinds of temperature, throughout the whole of last winter; and under all extremes of frost, he found they still retained their form and elasticity, and were impervious to the action of all gaseous matter.—The Chairman then remarked, that he presumed, from what had transpired on this subject, that it was the sense of the members that this was a very useful application, and that on all points, excepting that of durability, which time alone could determine, it had their approval.

We are sorry to find, from the Report before us, that Mr. Kintrea, who has so ably discharged the duty of Secretary since the retirement of Mr. Slate, has resigned his post. His close attention and efficient management have rendered his services of the utmost value to the Institution; and we have only to express a hope that his successor may possess the same ability for the transaction of the various duties connected with the office. Mr. W. P. Marshall, lately locomotive engineer, on the Norfolk Railway, has been put in nomination for the post.

ROYAL SCOTTISH SOCIETY OF ARTS.

Session 28.

The Annual General Meeting of this Society took place on the 13th of November last—George Buchanan, Esq., C.E., President, in the chair. In opening the business of the evening, the President, in remarking upon the condition and prospects of the Society, drew attention to the losses it had sustained by the death of several valuable members, amongst whom were the Duke of Argyll, the Marquis of Bute, and the Earl of Moray, noblemen whose station and character, and their great attention to agricultural and other improvements in the useful arts, were of essential service in promoting the interests and upholding the character of the Society. Sir George Mackenzie and Sir Thomas Dick Lauder, two most eminent members, whose character and talents, and their great interest in, and attention to, the matters of the Society, and whose valuable services, as well when they presided over it as at other times, were too well known to require any eulogy here; Sir Charles G. Stuart Monteith of Closeburn, well known by his great attention to the arts, and by various interesting communications to the Society. Of the professional members, he noticed the late eminent Mr. Nixon, architect in this city for the Woods and Forests Commissioners, and whose talents and high character, during the period he had been in Scotland, had gained the esteem of all who had the pleasure of knowing him. The Queen's Drive alone, which was entirely designed and executed by him, will remain a monument of his taste and skill. The Society has also lost Mr. Brookes, a young and promising engineer, cut off suddenly. Lastly, among the Associate Members was the name of the celebrated Mr. Thom of Ascog, near Rothsay, whose magnificent improvements in hydraulic architecture, exemplified in the Shaws and other waterworks, and his ingenious inventions of self-acting sluices, and plans for conducting and rendering available the waters of different districts, have raised him among the distinguished engineers of the day.

"An Exposition on the Strength of Materials as applicable to the Construction of Cast or Wrought-Iron Bridges" (Part III. on the Transverse or Cross Strain,) was then given by the President. This paper being a continuation of the able series begun by Mr. Buchanan, during last session, we may refer our readers to our pages 22, 46, 71, and 94, for the previous reports.

The Conway Tubular Bridge, in regard to which it was gratifying to observe, that it had now been in operation for upwards of three months, the regular traffic of the line going on, and trains passing and repassing daily, everything connected with it proceeding in the most satisfactory manner, and this truly wonderful design crowned with complete success. He then exhibited a drawing * of the Great Britannia Bridge, now in progress of execution across the Straits of Menai. This was exactly on the same principle as the Conway Bridge, but on a still more magnificent scale, the Straits here being so much wider, and the bridge, in order to keep the navigation free from obstruction, being elevated 102 feet above the surface of the water at the highest equinoctial tides. The breadth across the Straits at high water is about 1160 feet, and, including the banks to the abutment piers of the bridge, 1490 feet. This space is divided into four spans by a massive pier in the centre of the water-way, termed the Britannia Tower, 45½ feet thick, and two small piers or towers in the water at each side, 32 feet each, forming two spans in the centre, 460 feet in length each, and two half spans, one on each side. 230 feet.

Having been particularly requested by the Society, at the last meeting on this subject, to extend and complete his experiments on the tensile and compressive strengths of different stones, he would now state the result of these experiments. The mode of trying the direct *tensile* strength, was formerly exhibited by appending weights to the substance till it was actually torn asunder. In this way the strength of the different stones, by careful and repeated experiments, was found at an average as follows, viz.:—

	Breaking weight
Craigleith stone,	453 lbs.
Hailes —	336 "
Redhall —	326 "
Humbie —	283 "
Binnie —	279 "

Several other specimens had been prepared of marble, whinstone, Caithness and Arbroath pavement, and the results on these would be afterwards communicated.

The *compressive* strength of these substances, or their power to resist crushing, being generally far beyond their tensile strength, could only be tried conveniently by mechanical power; and he showed the apparatus which had been used for the

* This was an enlarged copy of a tracing by Edwin Clark, Esq., resident engineer, drawn for Professor Forbes, and by him kindly permitted, at the President's request, to be exhibited to the Society.

purpose, consisting of a combination of two levers. giving an increase of power of 30 to 1. The specimens, consisting of nearly exact cubic inches of the material, being placed near the centre of motion, and the upper lever brought down with a plate of metal to fall exactly on the stone, the weights were applied at the extreme end of the lower lever until the stone gave way. On trying, at the meeting, with this apparatus a piece of Hailes stone, it bore 3540 lb., and then gave way with a violent crash. A specimen of Craigleith stone was next tried, the side of the cube being about one-eighth part more than a square inch. This carried upwards of 6500 lb., when the sides began to skirt off, and with 6810 lb. it suddenly gave way, and was crushed to powder. In all these experiments it was observed, that when any part of the stone remained entire, it exhibited the same appearance noticed by Hodgkinson in the fracture of cast-iron—pieces breaking off at the sides at certain angles, and leaving a nucleus of a conical shape. Specimens of these were preserved, and may be shown at another meeting. By experiments of this kind, carefully made and repeated, he had found the *compressive* strength of the different stones as follows:

Craigleith gave way to a pressure of.....	4900 lbs.
Humbie,.....	3740 —
Hailes,.....	3530 —
Redhall,.....	3320 —
Binnie,.....	2820 —

In regard now to the transverse strain, this, as formerly explained, is of a compound nature, both the tensile and compressive forces being brought into play. A beam supported at the one extremity, and loaded at the other, becomes a lever, at the extreme end of which acts the weight tending to bend and break the material, by turning it round the point of support; while the power of resistance, residing in the section of fracture at the support, acts in the middle of that section, and at a distance from the centre of motion equal only to half the depth of the beam. The same is the case with a beam supported at the two extremities, and loaded in the middle; the beam, in that case, dividing itself in the centre into two levers, and half the weight acting at the extremity of each; while the strength of the beam acts as before in the centre of resistance, which is in the middle section of the beam. The notion of the beam turning round the point of support, and distending or stretching all the particles in the section of the fracture, which was that of Galileo, is not correct; the centre of rotation is in a point somewhere near the middle of the beam, and all the particles below this point are distended, while all the particles above this point are compressed or crushed together, while in the centre they are neither compressed nor distended, and hence this point has been termed the neutral axis. Much discussion has arisen regarding the exact position of this neutral axis—the limit between the tensile and compressive forces—a nice question, and one of abstruse and difficult investigation; and the probability is, after all, that it is not a fixed point, but is liable to vary with the nature and intensity of the strains. Be that as it may, it fortunately happens that the practical result as to the strength of the beam is almost exactly the same, whether the axis be supposed, with Galileo, at the point of support, or, with succeeding philosophers, at a point near the centre. In every case the strength depends, as formerly explained, on the length and depth of the beam, combined with its area at the section of fracture; and by these three elements the strength can be calculated in every case, provided we ascertain, by experiment, the actual strength of a beam or beams of given dimensions. Numerous experiments have been made with this view, and particularly on cast-iron, by Messrs. Hodgkinson and Fairbairn, and other observers. These were made on beams of various dimensions as to length, breadth, and thickness; but the calculation is simplified if we reduce them all to a unit or standard of 1 cubic inch—taking, for example, a bar 1 inch square, resting on supports 1 inch apart, and loaded in the middle; and the average result of all the different experiments is, that such a bar of cast-iron would bear a weight of 24,400 lbs., or very nearly 11 tons. The strongest specimen was of No. 3, cold blast, which gave 31,212 lbs., or nearly 14 tons; and the weakest, being one of No. 2, hot blast, gave only 19,278 lbs., or better than 8½ tons. The difference as to strength between the hot and cold blast appears to be trifling. The following are the strengths of some of the irons, given by Mr. Hodgkinson:—

Carron, No. 3, hot blast,.....	12.7 tons.
Do. do. cold blast,.....	10.9 —
Do. No. 2, hot blast,.....	11.1 —
Do. do. cold blast,.....	11.5 —
Low Moor, No. 2, cold blast,.....	11.4 —
Muirkirk, No. 1, hot blast,.....	10.1 —
Buffery, No. 1, hot blast,.....	10.5 —

Every other beam, then, will bear in this average proportion of 11 tons, in respect of the three elements above mentioned, namely—1st, the section of fracture; 2d, the depth of the beam; and, 3d, the length or distance between the supports; and the rule is, to multiply this average unit of strength of 11 tons, 1st, by the section of fracture; 2d, by the depth; and, 3dly, divide the product by the length. This is an universal rule, and one of most extensive application, and is here given in a somewhat simpler form than is generally found in elementary works. He then showed the effect, by experiment, on a cast-iron beam, one inch square, supported at the extremities at two feet apart, and loaded in the middle till it broke. By the above calculation of 11 tons for the unit, the strength would be 1068 lbs.; and it first deflected greatly, and then broke, all of a sudden, with a weight of 1140 lbs.; and as the exact area of the bar is about 1-10th more than an inch, this gives a unit of strength very nearly that of the average above mentioned. This specimen of iron was from Broughton Foundry, and he understood was of Summerlee iron, No. 2.

Mr. Buchanan then proceeded to the important subject of the *Form of the beam.* The simple rectangular beam is not the one best fitted for strength in proportion to the weight of the material employed. In the first place, the centre being the weak point, the mass at the ends may be reduced and accumulated in the centre, giving the beam a curved shape on the upper or under, or on both sides; and this is the form generally adopted in large beams or girders. The ends may be safely reduced to half or two-thirds of the depth in the middle; and for a load uniformly distributed over the beam, the surface should be formed to an elliptic curve, and for a load at the centre, to a parabolic curve. But, 2dly, the cross section of the beam, instead of being rectangular, can be modified with great advantage by removing the material from the central parts, and accumulating it, in the form of projections or flanges, either at the top or bottom, or both. If the flange be at the top, the cross section or the figure of the beam looking end-ways is that of the letter T; and if the flange be at the top and bottom, the figure is that of the letter I, with the head and tail extended. Originally the T form with the head or flange downmost was adopted in large manufactories or buildings for carrying brick arches, chiefly for the convenience of obtaining a bearing from which the arches on each side might be sprung. Afterwards the I or double T form was recommended on no less an authority than Tredgold. But the knowledge and consideration of the property of cast-iron, already described, in possessing a compressive strength much superior to the tensile, has given an entirely new view to the subject, and led to very important practical results. This is a discovery due to Mr. Hodgkinson; and the experiments and investigations which he has undertaken, in conjunction with Mr. Fairbairn, have rendered most essential service in this branch of practical mechanics. The upper part of the beam being compressed by the application of a weight, and the under part distended, and the tensile resistance being three or four times less than the compressive, it is evident that the material of the beam ought to be accumulated much more at the bottom than at the top; and in order to ascertain practically how far this principle might be carried, Mr. Hodgkinson made a variety of trials of different forms, beginning with the flanges equal at top and bottom, or the letter I form, then increasing the bottom flange by ten or twelve different steps, till he found at last the greatest strength was attained when the bottom flange, as in this figure ⌋, was six times greater than the top, and some very curious results arose from these investigations. The strength of the beams, formed according to those views, is easily calculated on the principle already explained; for, whatever be the form, it will be found that the strength is still very nearly proportional to the three elements—length, depth, and section of fracture; but the unit of strength or standard for each beam is different. For rectangular beams of cast-iron, this unit, as explained, is at an average eleven tons. For the equal flange beam, which was formerly considered a model, the unit is no greater, but rather, if anything, less; but when the bottom flange is increased beyond the top in the ratio of 4½ to 1, the unit of strength of every inch of the beam is increased to fifteen tons, and when the bottom flange is farther increased in the ratio of 6 to 1, the strength is increased to nineteen tons. He then showed by experiment the strength of a cast-iron beam 2 feet by 2 inches deep, bottom flange five times greater than the top, and area of fracture 1 inch. If rectangular, it should have broke with 2280 lbs., but it carried 3750 lbs. and then gave way, showing an increase of strength equal to 4170 lbs. gained by the form of the section. Since these experiments of Mr. Hodgkinson, others have been lately made by Bramah and others, particularly those under the sanction of government, in reference to the fall of the cotton-mill at Oldham, by Sir Henry de la Beche and Mr. Thomas Cubitt. These are important, as being made on a larger scale than the others. They entirely confirm the views and results of Hodgkinson, but the beams experimented on not being of the same forms, do not give the same degree of strength. On the whole, therefore, the results given above may be relied on, but the strains for perfect security ought on no account to be carried beyond one-fourth or one-third of the breaking weight.

Now that the nature of the transverse strain has been so thoroughly investigated, an important consideration arises, how far improvements may not still be made by the introduction of malleable-iron in conjunction with cast-iron, so as to form beams of a compound nature, having all the parts liable to compression of cast-iron, and all the parts liable to tension of malleable-iron. This has already been adopted, in some cases with success, by the introduction of what are called tension rods of malleable-iron; but it is extremely doubtful if the best combination of the two metals has yet been ascertained. The great point is to keep the two metals clearly and distinctly to their different offices of resisting compression and tension, and unless this be done there is difficulty and risk of bringing the one or other of them into action; and neither of them, in such cases, sustaining its proper share of the load or pressure, the most serious consequences may result from the combination. Owing to this, the use of tension rods has been rather condemned by engineers, and not without reason; but Mr. Buchanan thought the objections were not so much to the use of the tension rods, as to the injudicious manner in which they have been or may be applied. No general rule, he said, could be laid down, but one principle should never be lost sight of, that the strongest form is the simple one of the roof; the two rafters butting against each other at the top producing a simple compressive strain through their length, and at the bottom a horizontal thrust on the extremities of the tie or tension rod, producing simple distention. Forms might require to be modified by circumstances, but to this they ought all to tend, as to a centre involving the most perfect distribution of the forces. He then gave several illustrations of the mode of applying these ties, pointing out where they would be of essential service, and where they were objectionable and inefficient.

In many cases of railway bridges, the space between the level of the railway on the one hand, and sometimes a road, sometimes a stream, or navigable river, on the other, is so confined, that even with tension rods well applied, or massive girders, the span is so great as to occasion too enormous a strain to be safe or expedient; it is much better in such cases, rather than attempt to span the opening with too limited a depth of beam or girder, to acquire height by setting the girders on the

ontside of the railway, where an unlimited height can be obtained for arching, or frame-work of timber or iron; and this leads to the consideration of a remarkable species of bridge much used in crossing the vast openings of the American rivers, both for common roads and railways. It is termed the *Frame Bridge* or *Lattice Bridge*. These bridges have been most extensively applied, and with complete success, and, by successive improvements, have now been brought to great perfection; and as they possess some remarkable properties, and form an excellent illustration of the principle of dividing the tensile and compressive strain into distinct members of the bridge. he thought it might not be uninteresting to the Society to give a short explanation of them here. A very interesting account of these bridges, one of which, over the Susquehana at Columbia, of 29 arches, each of 200 feet space, is about a mile and a quarter in length, will be found in Mr. Stevenson's excellent work on the "Civil Engineering of North America," and through two engineering friends he had been favoured with farther information and drawings, which were exhibited.*

MONTHLY NOTES.

Improvement in Lithographic Printing.—Messrs. Lacroix and Sons, of Rouen, have now working at their establishment a steam lithographic press, which is capable of an extraordinary speed of production of impressions; throwing off 1700 sheets, 21½ × 25 inches, in a day of 10 hours. The machine is entirely automatic—wets its own stones—inks and performs all the movements, except the deposit and removal of the sheets, which a single boy accomplishes. It is stated to be simple, and absorbing but little power, whilst it is fitted for work of the most delicate character, and is guaranteed to produce from 2,800 to 3,000 impressions from the same stone. We shall probably be able to give more particulars of this invention shortly—remarking, that steam-power presses have been repeatedly tried in this country, and abandoned as unmanageable; the operation of printing from the stone, being one of those difficult processes which mechanical power has not yet mastered.

Mr. Dempster's Trawl-Fishing Experiments.—Since the article in the early part of our present number was written, Mr. Dempster has given us some further information on the subject, with the explanation of his reasons for not pursuing the matter further, in a second practical trial. It appears that, having laid his plans before the Honourable the Board of Commissioners for the Improvement of Scottish Fisheries, he was informed, that as his net was intended for taking soles, and that as the powers of the Board had reference only to herring, cod, ling, tusk and hake, no aid could be afforded to him from that quarter, however anxious they might be to assist in furthering improvements in fishing generally.—Until the superstitious ideas of the fishermen are removed, it will be vain to look for their co-operation. As Mr. Dempster pithily observes, "where is the fisherman to be found, that will readily adopt anything new, particularly if the novelty is really an improvement upon his own fishing-boat and gear? I believe there are many who, if the net was offered gratis, would not accept it; they would be afraid that it would 'frighten the fish out of the sea,' as I was once told by a courageous Newhaven fishwife."—After expending much time and money on the undertaking, he is just now no nearer his object than at first, and his only hope at present is, that the Commissioner appointed by government to inquire into the system upon which our Scottish fisheries are conducted, may deem the project a fit matter for the consideration of the government itself. When in Edinburgh a few weeks ago, the Commissioner inspected the apparatus—listened attentively to Mr. Dempster's detail, and has finally taken the whole apparatus to London for examination at head-quarters. An intelligent fisherman in Rothesay, who is well acquainted with the details of trawl-fishing, has paid some attention to the subject of the extension of the fishery by the means which Mr. Dempster has taken so much trouble to introduce—says, "The only suggestion I can offer as an improvement on your plan is, that the stretchers, instead of being round rod-iron, should be of an angular shape, so as to scrape under the surface of the sand; they would then be better adapted to disturb the flat fish, and should any oysters or clams be in the way, all would be scraped into the net!"—The proper section of rod is only to be found by trial in different grounds. A round rod is considered to answer for soft bottoms, but a different one must be necessary where harder soil is met with. The oyster-dredge now used, is liable to be capsized in the same manner as the trawl-net, and the improved trawl principle might probably be applied to it with advantage.

Wedgwood's Manifold Writer and Clip-Desk.—Mr. Wedgwood has been known for half a century, as an inventor and improver of articles connected with the writing-desk, amongst which, his "Manifold Writer," for the production of several fac-similes of writing at one operation, is the most eminently useful. As this contrivance has been before the world so many years, it is unnecessary for us to describe it further, than by stating that the effect is produced by writing upon a sheet of paper, which has placed below it a sheet of carbonized paper, placed over another of writing paper. By multiplying the folds or layers of paper, as many as eight copies may be taken at once, and by the operation of writing itself. An inconvenience has been sometimes found to arise from the want of some contrivance for keeping down the leaves in the act of writing, and this, the son and successor of Mr. Wedgwood, has accomplished in his "Clip-Desk." When in the arctic regions, where all the common ink was constantly frozen, Sir Edward Parry had good reason to be glad that he was furnished with the manifold writer, which appears to answer all expectations in every climate. The apparatus is arranged both as a stationary desk for the office, and for the traveller's purposes, where it is packed up into a space little larger than an ordinary book.

Dubois' Annulus Scapus.—We know not where the rage for outrageous names for books and inventions will stop. What is to be thought of *annulus scapus* as a title for a conical elastic ferule or wrapper for taps? The contrivance is nothing more than a substitute for the paper, string, &c., often applied to assist in the proper fitting of a tap to the vessel from which a liquid is to be drawn. By slipping on to the entering stem of the tap a short elastic cylinder, a liquid tight junction is made without recourse to the unsightly plan we have mentioned. The contrivance is well enough in its way, but is certainly overpowered by its name.

Brockliss' Flour Dresser.—M. Brockliss of the Castle Mills, Oxford, has lately registered a dressing-machine for flour, which is very similar to that of Mr. Sontham's of Nuneaton, figured and described at page 109, *ante*. The one of which we possess a drawing, is working at the Castle Mills, dressing from 15 to 16 sacks per hour. It is 4 feet 6 inches long, by 16 inches diameter. The brushes are constructed on the fan principle, and are made of two different materials—bristles and whalebone. The front, or actuating side of the brush, is of bristles, from 3 to 4 inches long, and they are supported by a back row of whalebone, one inch shorter. This arrangement is stated to produce a brush of very great elasticity and durability. The brush, as in Mr. Sontham's machine, does not touch the cylinder. In a letter to the Mark Lane Express, Mr. Lampett gives the inventor credit for having applied the fan-blast principle more than two years ago.

Ashby's Screw Friction Clutch.—The friction cone has been long employed as a simple means of effecting the engagement and disengagement of machinery, and, but for the difficulty of setting the two surfaces to work correctly, the contrivance would meet with much more favour. As usually adopted, a lever alone is used for keeping the interior and exterior cones in contact, and when so worked, a great weight is requisite to give security of action. Mr. Ashby of Greenwich has thrown aside the lever for the screw action; and in the drawing he has supplied to us, we find that he can bring his cones into action without involving the great pressure formerly so essential. The collar friction too is avoided, and thus the derangement consequent upon their wear is obviated.

Gilbert's Double Cylinder Steam-Engine.—Messrs. Gilbert & Co. of Hackney, London, have lately produced a beam condensing engine on the double-cylinder principle, containing various novelties of arrangement. It is of the vibrating pillar kind. the power being taken off by a connecting-rod attached to the beam, at a short distance from the end to which the piston-rod is jointed. The low-pressure expanding cylinder is placed below the foundation plate, quite out of sight; the axes of the two being coincident. In this way the valves for each are worked in a very convenient manner by one spindle. The air-pump is placed in the centre of the condenser, which stands below the floor line, beneath the longitudinal centre of the beam. An engine of this class, of 12 horse-power, is now at work, driving sawing machinery for 12 hours a day, the only fuel used being the saw-dust produced by its own labour.

The Preserver Envelope.—Mr. W. E. Jenkins of London has recently registered a design for an envelope, which certainly appears to merit the title of "preserver." It is intended to dispense with all attaching substances in the shape of sealing-wax or wafers. It differs from all others of its class in being fastened on the front, or direction side, by an adhesive preparation, and is so contrived that a postage stamp, placed in the usual position, forms an additional fastening, by crossing the point of junction of the two opening edges. A small opening is left at the left-hand bottom corner, for the introduction of a knife or other small instrument, for slitting up the angle of the flap; the letter can then be withdrawn, leaving a perfect case for its subsequent preservation. We found it impossible to obtain an entrance to the note contained in the specimen envelope furnished to us by the inventor, without dividing the actual material of which it was composed.

* For one of these drawings he was indebted to his old friend and assistant Mr. Lanrie, now engineer on some of the American railways; and for the other, along with interesting views as to the principles of construction, to Mr. Lawson, a friend and engineer, lately returned to Britain.

ENGLISH PATENTS.

Sealed from 18th November, 1848, to 11th December, 1848.

Thomas Masters, Regent-street, Middlesex,—"Certain improvements in apparatus for making aërated waters, and in apparatus for charging bottles and other vessels with gaseous fluid; also, improvements in bottles and other vessels and apparatus for drawing off liquids, in securing corks or stoppers in bottles or other vessels, and in taps or vent pegs."—November 18th.

Thomas Cullen, London, gentleman,—"Improvements in apparatus for steering ships and other vessels."—18th.

John Juckes, Rosamond Cottage, Fulham, gentleman,—"Improvements in furnaces and fire-places."—18th.

Alexander M'Dougal, Longsight, Manchester, chemist, and Henry Rawson, of the same place, agent,—"Improvements in the manufacture of sulphuric acid, nitric acid, oxalic acid; chlorine, and sulphur."—21st.

John Oliver York, 24 Rue de la Madeline, Paris, engineer,—"Improvements in the manufacture of metallic tubes."—21st.

William Hood Clement, Philadelphia, United States of America, gentleman,—"Certain improvements in the manufacture of sugar, part of which improvements is applicable to evaporation generally; also, improved apparatus for preparing the cane trash to be used as a fuel."—21st.

Henry Newson, Smethwick, Birmingham,—"An improvement or improvements in trusses."—23d.

Hugh Bell, London, gentleman,—"Certain improvements in aerial machines and machinery in connection with the buoyant power produced by gaseous matter."—23d.

Christian Schiele, Manchester, mechanician,—"Certain improvements in the construction of cocks or valves, which improvements are also applicable for reducing the friction of axles, journals, bearings, or other rubbing surfaces in machinery in general."—23d.

Peter Llewellin, Bristol, Gloucestershire, brass and copper manufacturer, and John Hemmans, of the same place, brass-founder,—"Improvements in the manufacture of cocks or valves for drawing off liquids."—23d.

Henry Archer, Great George-street, Westminster, gentleman,—"Improvements in facilitating the division of sheets or pieces of paper, parchment, or other similar substances."—23d.

Frederick Bramwell, Millwall, Poplar, engineer, and Samuel Collet Homersham, of the Adelphi, gentleman,—"Improvements in feeding furnaces with fuel."—23d.

Pierre Armand Lemcote de Fontainemoreau, Skinner's-place, Size-lane,—"Certain improvements in the process of, and apparatus for, treating fatty bodies, and in the application of the products thereof to various useful purposes."—(Communication.)—25th.

John Goucher, Woodsetts, West Riding of the County of York, agricultural machine maker,—"A machine for thrashing corn and other grain."—25th.

John Lane, Liverpool, and John Taylor, Liverpool, engineers,—"Improvements in engines, boilers, and pumps in rotary carriages, in propelling vessels, in the construction of boats, in extinguishing fire, and in brewing."—29th.

Edward Schunck, Rochdale, Lancashire, chemist,—"Improvements in the manufacture of malleable iron, and in treating other products obtained in the process."—26th.

William Rothwell Lomax, Banbury, Oxford, engineer,—"Improvements in machines for cutting hay and straw into chaff, and for cutting other vegetable substances."—29th.

Jonah Davies and George Davies, Albion Iron Foundry, Staffordshire, iron-founders, —"Improvements in steam-engines."—December 2d.

Robert Burn, Edinburgh,—"An improved roller gin, used in separating the seed from cotton."—2d.

Francis Hastings, Greenstreet, Liverpool, engineer,—"Certain improvements in hydraulic engines."—2d.

John Armstrong, Edinburgh, brass-founder,—"Improvements in constructing water-closets."—2d.

William George Armstrong, Newcastle-upon-Tyne, gentleman,—"Certain improvements in steam-engines."—2d.

Frederick Collier Bakewell, Hampstead, gentleman,—"Improvements in making communications from one place to another by electricity."—2d.

William Young, of the firm of Henry Bannerman and Sons, Manchester, merchants,—"Certain improvements in machinery or apparatus for winding, balling, or spooling thread, yarn, or other fibrous materials."—2d.

Robert Nelson Collins, Oxford-court, Cannon-street, druggist,—"Certain improved compounds to be used for the prevention of injury to health under certain circumstances."—2d.

James Taylor, 15 Furnival's-inn, gentleman,—"Improvements in propelling ships and other vessels."—2d.

John Henderson Porter, Adelaide-place, London Bridge, engineer,—"An improved mode of applying corrugated iron in the formation of fire-proof floors, roofs, and other like structures."—2d.

John Duley, Northampton, iron-founder,—"Certain improvements in the construction and arrangement of stoves for cooking and other purposes."—2d.

Thomas Drayton, Regent-street, practical chemist,—"Improvements in silvering glass and other surfaces."—2d.

James Young, Manchester, manufacturing chemist,—"Improvements in the preparation of certain materials used in dyeing and printing."—9th.

John Gardner, Wokingham, engineer,—"Improvements in girders for bridges and other structures."—9th.

William Ironside Tait, Rugby, Warwickshire, printer and bookseller,—"An improved method or methods of producing outlines on paper, pasteboard, parchment, papier mache, and other like fabrics."—9th.

Andrew Lamb, Southampton, engineer, and William Alltoft Summers, Millbrook, Southampton, engineer,—"Certain improvements in steam-engines and steam-boilers, and in certain apparatus connected therewith."—9th.

John Tutton, 20 South Audley-street, Grosvenor-square, mechanist,—"Certain improvements in the construction and arrangement of certain parts of huildings."—9th.

Christopher Nickels, Albany-road, Camberwell, gentleman,—"Improvements in the manufacture of gloves and articles of dress and furniture."—9th.

William Palmer, Sutton-street, Clerkenwell, Middlesex, manufacturer,—"Improvements in the manufacture of candles."—9th.

George Lawrence Lee, Holborn, lithographer,—"Improvements in producing ornamental designs."—11th.

Edmund Hartley, Oldham, Lancashire, mechanic,—"Certain improvements in machinery or apparatus to he employed in the preparation and spinning of cotton and other fibrous substances."—11th.

SCOTCH PATENTS.

Sealed from 20th November, 1848, to 20th December, 1848.

John Armstrong, Edinburgh, Mid-Lothian, brass-founder,—"Improvements in constructing water-closets."—November 23d.

Edward Duncombe Lines, Chelsea, soda-water manufacturer, and Samuel Luz Freemont, Love-lane, London, gentleman,—"Improvements in the manufacture of colours, oils and varnishes, acids and spirits, and in the manufacture of charcoal, and also in treating vegetable substances for, and in obtaining and treating extractive matters therefrom."—24th.

Joseph Lewis, Salford, Lancashire, machine-maker, and William M'Lardy, of the same place, manager,—"Certain improvements in machinery or apparatus applicable to the preparation and spinning of cotton, wool, silk, flax, and other fibrous substances."—24th.

John Harris, 4 Richard's-terrace, Albion-street, Rotherhithe, Surrey, engineer,—"A mode or modes of fonuding type, and of casting in metal, plaster, and certain other materials."—28th.

Alexander Parkes, Birmingham, Warwickshire, chemist,—"Improvements in the manufacture of metals, and in coating metals."—30th.

Alexander Balfour, Dundee, Scotland, leather merchant and manufacturer,—"Improvements in apparatus for cutting metal-washers and other articles, and in the construction of buffers."—December 4th.

Christian Schiele, Manchester, Lancashire, mechanician,—"Certain improvements in the construction of cocks or valves. which improvements are also applicable for reducing the friction of axles, journals, bearings, or other rubbing surfaces of machinery in general."—4th.

William Young, of the firm of Henry Bannerman and Sons, Manchester, Lancashire, merchant,—"Certain improvements in machinery or apparatus for windiug, balling, or spooling thread, yarn, or other fibrous materials."—8th.

Alfred Vincent Newton, Office of Patents, 66 Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in casting printing types, and in other similar raised surfaces, and also in casting quadrates and spaces."—11th.

James Henry Staple Wildsmith, City-road, experimental chemist,—"Improvements in the purification of naphtha (likewise called wood-spirit and hydrated oxyde of methyle), pyroligneous acid, and cupion, and certain other products of the destructive distillation of wood, peat, and certain other vegetable matters; and of acetate of lime and shale; and in the purification of coal tar and mineral naphtha; likewise spirit being the products of fermentation."—12th.

Henry Newson, Smethwick, near Birmingham, Staffordshire,—"An improvement or improvements in trusses."—13th.

Duncan Mackenzie, Goodman's Fields, Middlesex, manufacturer,—"Certain improvements in jacquard machinery for figuring fabrics and tissues generally, and apparatus for transmission of designs to the said jacquard machinery, parts of which are applicable to playing musical instruments, composing printing types, and other like purposes."—(Communication.)—22d.

IRISH PATENTS.

Sealed from 20th November, 1848, to 20th December, 1848.

Joseph Eugene Asaert, Lille, Republic of France, machinist,—"Improved means of obtaining motive power."—November 22d.

Pierre Frederic Gougy, Leicester-square, Middlesex, gentleman,—"Improvements in apparatus and machinery for raising, lifting, and otherwise moving heavy bodies."—30th.

Alfred Vincent Newton, Office for Patents, &c., Chancery-lane, Middlesex, mechanical draughtsman,—"Certain improvements in the manufacture of steel."—(Communication.)—December 2d.

Joseph Lillie, Manchester, Lancashire, engineer,—"Certain machinery or apparatus applicable for purifying and cooling liquids, and for purifying, condensing, and cooling gases."—5th.

Hugh Bell, London, gentleman,—"Certain improvements in aerial machines and machinery in connection with the buoyant power produced by gaseous matter."—9th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 17th Nov., 1848, to 13th Dec., 1848.

Nov. 17th, No.	1669.	William Broughton, South-street, Finsbury,—"Universal stove."
—	1670.	H. Austin, Gwydir House,—"Drain-pipe, with single half-socket joint."
20th,	1671.	George Perrott, Hive Iron Works, Cork,—"Portable capstan."
—	1672.	James Lyne Hancock, Goswell Mews, London,—"Self-acting hose-pipe reel."
22d,	1673.	Cobett Whitton, Sixall Heath, Stafford,—"Remington and Whitton's farmers' and graziers' portable mill."
—	1674.	William Kirkwood, Edinburgh,—"Water-closet."
—	1675.	Bryden & Sons, Edinburgh,—"Safety receiving-box for letters and parcels."
23d,	1676.	Charles Rowley, Birmingham,—"Ticket-holder."
—	1677.	John Ferrabee & Son, Stroud, Gloucester,—"Knife, with guard, for cutting vegetables and other substances."
—	1678.	Joseph Ashforth & Co., Sheffield,—"Ratchet wrench or spanner."
—	1679.	William Tortoise, John-street, Clerkenwell,—"Paper-cutting slide."
24th,	1680.	Thomas Evans, Southampton-street, Strand,—"Expanding shirt collar."
—	1681.	Henry Browne, Walworth.—"A bath cock."
—	1682.	Frederick Allen, Birmingham,—"Brooch fastening."
—	1683.	Jarrold & Sons, St. Paul's Churchyard, London,—"Juvenile artists' drawing table."
25th,	1684.	John Gilby, Chelmsford,—"Reins for driving or riding."
—	1685.	The Broomsgrove Railway Carriage Company, Broomsgrove,—"Pipe joint and fastening."
27th,	1686.	Haldane & Roe, Edinburgh,—"Tap or cock for drawing off liquids."
—	1687.	John Petrie, Rochdale,—"Wringing and mangling machine."
—	1688.	J & W. Robertson, Ardrossan,—"Pentagraphic delineator."
30th,	1689.	Clarke & Timmins, Birmingham,—"Music stool, screw tube, and box."
Dec. 1st, No.	1690.	E. Slyn and W. Green, Wolverhampton,—"Cabin door lock."
4th,	1691	Captain H. Mangles Denham, R.N., Senior United Service Club, Pall Mall,—"Tiller."
5th,	1692.	Joseph Faulding, Robert-street, Hampstead-road,—"Apparatus for applying steam and vapour heat to parts of the human body."
—	1693.	James Hayes, Elton, Huntingdonshire,—"Pedo-manu-motive."
6th,	1694.	Thomas Barr, Glasgow,—"Duplex block for printing yarn in the hank."
7th,	1695.	John Gedge, Wellington-street, Strand,—"Safety hammer for the locks of percussion fire-arms."
—	1696.	Henry Smith and Thomas W. Ashby, Stamford,—"Agricultural cart."
12th,	1697.	James Tod and Son, Edinburgh, engineers,—"Railway carriage cork buffer."
—	1698.	John Rogers, Kennington,—"Draft accelerator."
13th,	1699.	T. H. Thomson, C.E., Strand,—"Blind roller."
—	1700.	James Wallis Dann, Cromer-street, Gray's Inn-road,—"Ball-valve."

TO READERS AND CORRESPONDENTS.

Mr. Curr.—His long communication on "Thermometric Observations," hardly appears to touch on the real point at issue. If he will confine himself entirely to the original terms of the query, we shall be glad to publish his conclusions. As it is, the reply is too long, and, we fear, too vague.

Northfleet, Kent.—A correspondent, who dates from this place, has forgot to mention his name. His request will be punctually attended to on receiving it.

J. P., Birmingham.—We shall be glad to hear further of the matter he mentioned in his letter.

F. Pastorelli.—We are again obliged to delay the subject. We shall have an additional notice to append to it next month.

A Millwright, Dundee.—The Turbine of M. Fourneyron is, in many respects, inferior to the best reaction wheels constructed in this country. The invention has not been published in the work he mentions. That at St. Blazien, in the Schwartzwald, is the best continental example of this class of machines. It has a fall of 351 feet, and drives the machinery of a spinning mill, numbering 8,000 throstle spindles, with preparations. We have no accurate information as to its expenditure of water.

Jonx, Birmingham.—We shall be glad to learn his remarks on the subject, which deserves the careful attention of all interested in the economy and safe management of steam-power.

G. E., Manchester.—If he consults Weale's "Engineer's and Contractor's Pocket-Book," Templeton's "Workshop Companion," or other similar mechanical guides, he will find all the information he wants, laid down in the clearest style. We might write for half a day, without rendering him as much assistance as he will obtain from any of these works in half an hour. However, as he appears anxious to have our own explanation, we may tell him he is quite right in his supposition, only that he has made no allowance for the weight of the lever, which certainly acts as an additional weight on the valve. He must first take the weight as found without reference to the lever; and then attach a spring balance to the fulcrum, or point of pressure upon the valve, adding the valve's own weight to the indicated weight of the lever. Gun barrels may be stained with aquafortis or other acid, according to the tint desired. The locks are hardened either in oil, or with animal carbon, in the usual manner. Good examples of the machinery he mentions, will appear as occasion may serve. We are sorry the plate has not satisfied his expectations. Can he point out any better ones?

R. S., Manchester.—His query was too late for consideration this month. It will be attended to in the next No.

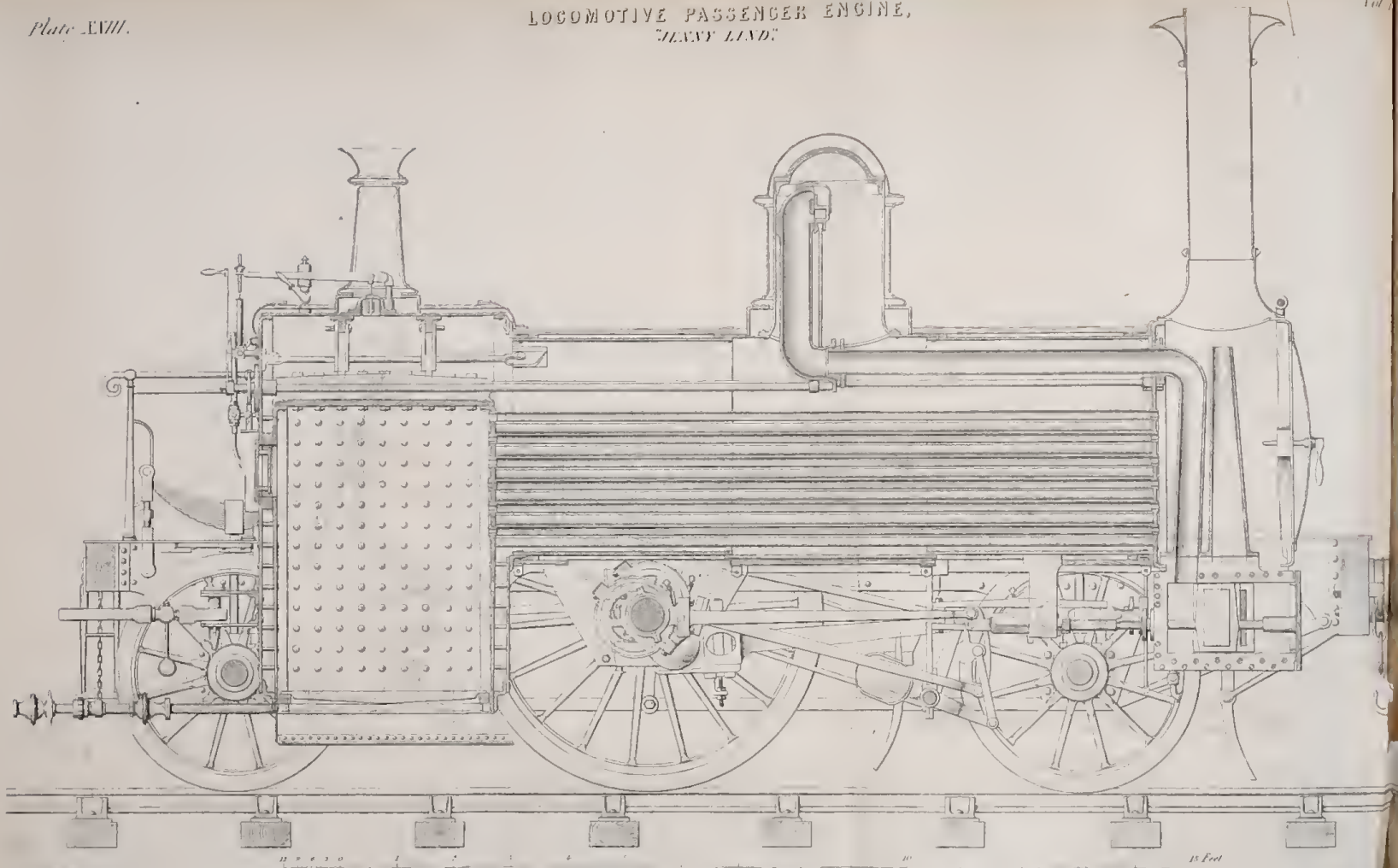
Mr. Allenby, London.—The sketch has been received, and will be remarked upon in our February No.

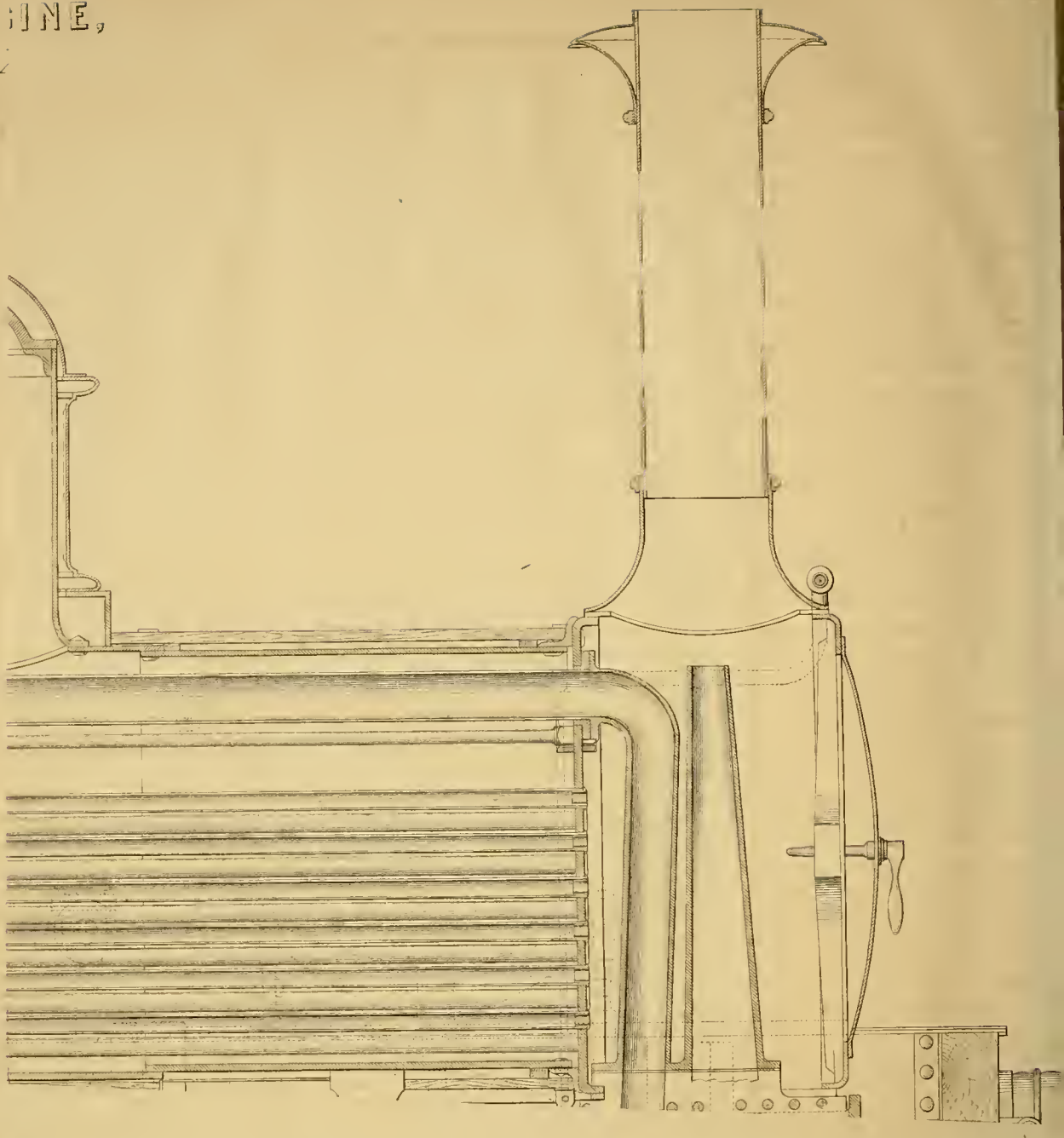
G. R. E.—Next month.

S. S., Stamford.—His crank motion is ingenious, hut we do not see what advantage it would have over the crank alone. Gearing does not answer for these purposes.

Plate LVIII.

LOCOMOTIVE PASSENGER ENGINE,
"JENNY LIND."





THE POLITICAL ECONOMY OF MACHINERY.

Our leading article this month consists of a translation of the chapter relating to machinery, in a recent French work on Political Economy.* The work to which we refer, is so excellent a summary of the leading truths of the science, that we should rejoice to see the public in possession of a translation of the whole, and we understand that such a translation is in progress.

By implements and machines must be understood, the instruments with which man arms his feeble powers in working upon and with material objects. Implements are the simplest form of machines, machines are complicated implements. In the eyes of the economist, there is no other difference between the two.

By machinery the productive powers of man are increased. It forms a part of his capital; it is a consequence of the division of labour, and of the accumulation of capital.

Machinery furthers the aims of labour, by pressing into its service the properties of matter; and thus human labour is husbanded and turned to better account, and the same amount of produce can be obtained by a less number of labourers.†

It is in this that the great advantage of machinery consists; and yet there are some persons who look upon this advantage as a great inconvenience, because they regard the immediate injury flowing from the saving of human labour, as greater than that resulting from the dearness of the commodity produced. But what such persons regard as a slight matter, (writes J. B. Say,) is the principal obstacle in the way of social progress. Let us suppose that commodities cost no labour to produce, and that they were to be procured for nothing; labourers, it is true, would be without work, but then they would have no need to labour. Now, all economy of labour is a step to that end. That end will evidently never be reached; but the economizing of labour makes commodities become progressively cheaper for the general benefit of society. Would we condemn, as evils, inventions which would produce bread ready baked in the field, wine flowing from the vine in the vineyard, cloth woven on the backs of animals, and implements coming perfect and complete out of the mines? Now, if machinery does not work such marvels as these, it fulfils at any rate a part of those desires of ours, which would formerly have been deemed dreams, in economizing the time and toil of the human race.

The results of machinery may be rendered more apparent by an instance adduced by J. B. Say. An ordinary water-mill will grind twelve quarters of grain per diem, a quantity which would require the labour of one hundred and sixty-eight men, for the same time, to reduce to flour. For the neater working of the calculation, let us substitute 150 for this number, and we shall have 150 men at 2 francs (1s. 7d.), costing the neighbourhood of Paris 300 francs, (£11 13s. 6d.) In the same district, the rent of a stream will amount to 3000 francs. Now that sum distributed over 300 working days, gives an expense of 10 francs (7s. 11d.) per diem, instead of 300 francs (£11 13s. 6d.), which the cost of manual labour would have amounted to. And thus 290 francs on 12 quarters of grain (more than 18s. 2d. per quarter) is saved, that is, one-half of the cost of the grain itself—and the expenses of making bread are reduced at least two-thirds.

The saving of expense is not denied; but it was in the first place pretended (this was Montesquieu's objection) that the labouring millers were the sufferers, their wages being diminished to that amount; and, in the second place, that nothing more than a change of investment takes place. But can it be denied, that, if we pay 190 francs less to the labouring millers, we leave their time and labour at their own disposal, and these they can thenceforth employ in the making of other things? But who will buy these other things? it may be asked. The same who have saved 190 francs in the price of flour. Thus flour having become more abundant and less dear, more persons are able to purchase it.

Moreover, machinery multiplies the fruits of the intellect, and emancipates man from labour. If the only method of cultivating the soil were by the spade, or other instruments as simple—if our labourers could not call to their assistance the plough and the animals which draw it—it is probable that there would be required, in the production of the means of subsistence, all the hands which are now employed in other ways. The use of the plough, therefore, permits a great number of persons to apply themselves to the sciences, the arts, and the cultivation of all the faculties of mind and heart. We must also thank machinery that the operative is gradually being freed from the most toilsome and disgusting labours which debase and brutalize him. The condition at which we should be constantly aiming is that of a society, where every mechanical operation is performed by animals or machinery, and where the only human labourers are overseers.

These facts, however, are not so decisive as one might suppose, and many writers have combated the introduction of machinery. Sismondi, especially, has insisted on its pernicious effects. Starting with the proposition that the requirements of nations are fixed in quantity, this author affirms, that every time consumption exceeds the means of production, every new invention is a benefit to society, and that when production fully equals the demands of the consumers, every new invention is a calamity. In reply, J. B. Say denies that the requirements of a nation are fixed in quantity and known, because population is continually augmenting, and because we every day make use of productions of which those who went before us were ignorant, just as our successors will make use of things of which we have no idea. He remarks, moreover, that the fruits of one producer's labour may furnish him with the means of purchasing those of another; that, in consequence of this double production, they are both better off than before; and that, in general, if there is excess in one kind, it is that there is deficiency in another. If we object that certain requirements have necessary limits, and that there ought not to be, for example, more hats in a country than heads, he replies that the increase of productions, other than hats, can to a certain degree augment the number of heads.

Sismondi has also averred (and the same thing has been frequently repeated after him), that it is much better to have a country peopled with citizens than machines. A reply is ready: machines do not diminish the quantity of food; and if there are persons in want of food, that is a defect of distribution, with which machinery has nothing to do.

But it must be admitted that machinery drives men to change their occupations, and that is not done without inconvenience. It is a troublesome matter to go through another apprenticeship, and then an opportunity of turning the acquired ability to account may not be immediately met with. Hence arise anxieties and sufferings, for which, up to this time, none but trifling palliatives have been applied. Here again a complex problem presents itself for solution, a problem which interests not only the lower classes, but the whole of society. The inconvenience is great in proportion to its suddenness. The discovery of twisting by machinery, and that of the steam-engine trade, one after the other, towards the end of the eighteenth century, were necessarily followed by alterations in every system of manufacture, which led to much difficulty.

However, as these inconveniences are in general only temporary, and since, moreover, the steps by which nations arrive at civilization and

* Eléments de l'Economie Politique, Exposé des Notions Fondamentales de Cette Science, par Joseph Garnier. Second edition. Paris, 1848.

† It was reckoned that there were in France, in 1844, 3645 steam-engines, which, with a power of 45 thousand horses, represented a population of a million of men. Chevalier, in his Course of Political Economy, has adduced some striking facts with respect to the part played by machinery and its power, as well as with respect to the productiveness of our times compared with past days. Formerly, a labourer, working as they do at present in the Pyrenees, would obtain twelve or thirteen pounds of iron. A labourer now-a-days, by the aid of blast-furnaces, will produce thirty times as much. In the time of Ulysses, a man made in a day, flour for 25 persons' consumption. At St. Maur, near Paris, a single mill and twenty men make flour daily sufficient for 72,000 persons; or with one man, for 3,600 persons. Since Ulysses' time, the advance is as 144 to 1. Before 1769, 320 spinners were required to produce as much as one workman, who, in company with four others, manages in these times two looms. On a railway, one man is capable of conveying, in the United States, as much as an army of 11,500 Mexicans in the time of Montezuma.

abundance are not to be arrested by them; it is another reason why we should endeavour to find a means of indemnifying those whom a new invention injures, by depriving them of employment, whilst society is benefited. To the present time, no expedient, but the erection of public works, has been found for absorbing the sudden superfluity of operatives, and the formation of economic committees to provide for the crisis. As to public workshops, these cannot be supported except by taxation, and taxation falls heaviest upon the poor. Besides, these workshops can only be a limited and temporary resource. We arrive, therefore, at this conclusion, that the ill effects arising from the introduction of a machine will be less felt the better society is organized, and when the persons thrown out of employment shall be able more easily to reinstate themselves in some other occupation. But machinery must not be rendered responsible for crises and gluts brought about sometimes by a mania for speculation, sometimes by a mischievous fiscal legislation, and sometimes by the unskilfulness, that is, the ignorance, of speculators.

It has been foolishly proposed to proscribe machines; but it is clear that their introduction is unavoidable, and that the country which refuses to admit them would only increase its difficulties. If France had not adopted the machinery for twisting cotton, the thread would have been manufactured elsewhere, and thus one evil would have been substituted for another. On reflection, we may perceive that the evil is not here. The point is not to ascertain whether we can drive a stream back towards its source, but to anticipate the violence of this stream—to fortify ourselves against its irregular movements—above all, to take advantage of its benefits. Another consideration also governs this question. If there were a prohibition of such machinery, it would be impossible to lay down a distinction between machines necessary to be allowed, and those to be prohibited. The pulley, the pincers, the plane, the plough, the cart, the spinning jenny, the hydraulic wheel, the steam-engine, and all chemical and physical discoveries, are more akin than we may think.

Again, it has been proposed to keep only the most necessary and the least complicated, those which take the least work out of the operative's hands—in short, to proscribe the new machinery only. But, at the very threshold of these different systems of classification, we cannot but see the impossibility of acting upon them. It is curious to run through a list of the machines which the most thorough enemy of machinery would be compelled to admit, either because their construction supports thousands of hands, or because they perform what man himself is unable to do. Of the number are clocks, presses, pumps, fire-arms, &c., employing so many workmen; circular saws, mills, steam-engines, with which we cannot dispense in propelling ships, draining mines, &c. &c.; and the plough, how could that be replaced? The mention of this implement clenches the argument. How much of progress in this machine—what services, what helps afforded to liberty!

Happily, however, many circumstances smooth away the embarrassments which momentarily result to the working classes by the introduction of machinery. In the first place, machinery is in general of a high price, and a large capital is requisite to put it in operation. If this difficulty does not in the end prevent its adoption, it retards at least the period. The history of the development of most branches of industry affords a convincing proof of this. Secondly, the habit of routine, the dread of innovation, and of the loss of capital, are impediments in the way of the use of new inventions, rendering the transition gradual, and sometimes removing the inconveniences altogether. Thirdly, in proportion as the arts grow perfect, the invention of machinery becomes more difficult. There are, besides, other considerations. The want of work is not less distressing in places where there is no machinery. It is not the assistance which human hands receive that occasions the misery of a people, but the excess of population, the want of industry and activity, the shortness of capital, a bad government, &c. There was scarcely any machinery in England in the time of Queen Elizabeth, and yet it is from her reign that we date the law for the support of the poor. And in our days, operatives are never so badly off as in the countries where no machines have been introduced. They die of hunger in Poland, in Ireland, and in China. We must remember, also, that manufactures are liable to many vicissitudes from one cause or another, no matter what may be the mode of production.

In many cases, machines, far from supplanting human labour, have multiplied it. In fact, every abridgment of labour, by reducing the cost of production, carries the manufactured article to the door of a greater number of consumers; and experience proves that consumers multiply in a greater degree than the price decreases, especially when the method of manufacture improves the commodity. The diminution of the price by a fourth, has been known to *double* the consumption. We will only cite two examples—printing and cotton spinning. Although the steam-press enables one man to do the work of two hundred, the multiplication of books, the arts which are connected with them, such as the casting of type, the fabrication of paper, the professions of author, corrector, binder, &c., employ a thousand times as many persons as formerly were occupied in them.* And what a difference in form and price between the manuscripts of early times, and the books of the present! When we observe the perfection of the machinery for spinning cotton, and the admirable rapidity with which the bobbins are covered with thread, we may fancy that the greater number of persons formerly employed in spinning have been thrown out of work; yet precisely the reverse has happened. Before the invention of machinery, only 5200 female spinners at the wheel, and 2700 weavers, altogether 7900 persons, were employed in England; whilst in 1787, ten years later, 150,000 spinners, and 247,000 weavers, or 352,000 persons, were reckoned. Since that time, mechanics have passed into another phase. The same business is done with fewer workmen, and steam has taken the place of manual labour in a great number of manufactures. However, the number of workmen has increased. Mr. Baines, in his History of the Cotton Manufacture, has established, that in 1833 there were 237,000 spinners or weavers by machinery, and 250,000 loom-weavers, in all 487,000 persons. Adding the persons employed in collateral branches of industry, such as printing on stuffs, the making of tulles, embroidery, caps, &c., Mr. Baines arrives at the number of 800,000; or 1500,000, taking into account the old men, women, and children, supported by the work-people; and two millions, reckoning the carpenters and masons employed in building manufactories, and the makers of loom-frames, without their children, and old persons. We arrive at the same figures in comparing the cotton imported in 1769, and that imported in our days. Although it is possible there may be statistical exaggerations, we cannot but acknowledge the great increase of labour employed in the cotton manufacture, in consequence of the invention of machinery intended to abridge it, without taking into account the sailors, the carriers, the merchants, the travellers, the brokers, and the retail dealers, who are engaged in it, each in their own business.

The history of the cotton manufacture would furnish matter which would admit of considerable expansion, if we were to analyse the prodigious increase in the consumption of cotton throughout the world, the employments of various kinds to which it has given rise collaterally, not only amongst the manufacturing classes, but amongst the commercial and agricultural classes as well, and the various products which it has been necessary to make in order to obtain those immensely valuable accumulations of manufactured cotton.†

Thus, if it be true that machinery, at a given moment, displaces human labour, it is not slow to create employment for a much more considerable

* See an account of the improved "Times" machine, in a subsequent page.—[Ed. P.M.J.]

† In 1834, M. de Jounés, in his Statistics of Great Britain, thus summed up the comparative conditions of the cotton trade in Great Britain and France. Annual manufacture: in England, 900 millions of francs; in France, 250 millions. Home consumption: in England, 400 millions; in France, 193 millions. Individual consumption: in England, 16 francs, 66 centimes; in France, 6 francs, 86 centimes. It was calculated that the cloth exported from England in 1833, was long enough to go ten times and a half round the earth. In a paper, published in the *Journal des Economistes* (vol. 16.)t he exportation of woven goods from the same country in 1845, is estimated at 479 millions of francs; that of thread, at 176 millions; and the demand in 1843, at 263 millions. A franc, we may remind the reader, is worth 9½d. of our money.

number, and to compensate injury to individuals by a benefit to society, namely, by enlarging the supply of commodities, and diminishing their price, by stimulating consumption, and by multiplying enjoyments, which increase capital and the demand for labour.

These facts would also be an answer to that other allegation, that machinery depresses wages, because the demand for labour will not increase, unless those who employ labour are able to employ and remunerate the increased demand. Machinery for spinning cotton, so far from reducing wages, actually raised them during the first ten years after the invention came out. A woman earned two francs fifty centimes, in place of one franc; and a man earned five francs, instead of two. Wages were afterwards lowered, by the disproportionate increase of the population; but it is well to remark, that in 1833 Mr. Baines established, by very plausible calculations, that if the 7900 operatives of 1769 had between three and four millions of francs amongst them for wages (three or four francs each), the 800,000 of our days had 455 millions, (560 francs each.) The railways offer analogous facts. We might suppose they would put down drivers, grooms, postilions, &c., and render horses less useful and less expensive. Exactly the contrary has happened; and nothing is easier to explain. Do not railways multiply travellers and traffic? and, as a consequence, are not the lateral ways of communication more used, as well as horses upon them?

The perfecting of the means of intercourse diminishes the cost of production, and advances the industry of a people. There is an intimate connection between the improvement of the means of conveyance and that of markets. Our epoch will be especially remarkable for the improvement of the means of communication—rivers, canals, roads, and railways. The last, especially, seem as if they would change the face of the world. Following and assisting this formidable development of steam, the results which the new mode of communication do and will produce are incalculable. The statist will, some time or other, disclose them to us. Travelling becomes a thousand times more common; some villages will assume the importance of towns, and many towns will certainly lose rank. The localities of industry have already been greatly moved; some will be reanimated, others will disappear; joys, griefs unheard of, will flow from the new phases of production, so radically modified by these new and powerful organs of conveyance. In some there will be destruction in some particulars, but reanimation on the whole. But nothing can give us any idea of the mysterious revolution which time has in store, not even the extraordinary results at the end of the last century and the commencement of the present one, of cotton spinning by machinery, and in all branches of industry dependent and similar. It is remarkable that steam is still the first cause, with the simple addition of two rails.

The impulse has been given. The United States, England, and Belgium, have for some years been furrowed by these new modes of communication; Germany and Russia have tasted of this enormous influence; France is hastening forward in the same path; Northern Italy already possesses lines of railway; and the rest of the Peninsula is striving to obtain others. Spain, Portugal, Sweden, and other countries, are also alive to the impulse.

All that we have said of machinery is likewise applicable to discoveries of every kind; to all processes, of what nature soever they may be, which aim at producing more quickly in a better manner—in other words, at a cheaper rate.

THE AURORA BOREALIS OF THE 17TH NOVEMBER, 1848.

By Mr. R. Smith.

The Aurora Borealis is a frequent spectacle in Scotland, where it very generally obtains the name of "streamers;" but seldom has it been seen here to such perfection as on the nights of the 18th of October, and the 17th of November last. The peculiar brilliancy of the sky on the latter evening indeed merits especial notice. The day preceding was beautifully fine, with a clear sky and bright sunshine; but towards evening the sky became dimmed, and a little rain fell, after which it again cleared, with the exception of the presence of a few fleecy clouds. About a quarter before 7 p.m. a soft and gentle light began to illumine the northern region of the sky, and at 7 a considerable portion was covered with streams of light, of a dark red colour; whilst the south and north were occupied with streamers moving to and fro, tinted with gold and silver. At 8, a ring, of an elliptical form, made its appearance near the zenith, and upon the magnetic meridian, and from it, beams or columns of light proceeded in all directions towards the horizon, giving to the arch of heaven the semblance of a splendid dome, having its top adorned with a crown or wreath; whilst, around and within the dome, were to be seen brilliant lights flashing towards the crown, or central circle, now tinged with prismatic rays, and anon intensely white and lucid.

About half-past 9, nearly the whole of the aerial canopy was covered with bright red clouds, casting a curious reddened glare on all sublunary objects. Shortly, the red tint began to dim, and its place was again occupied by the white dome, the red remaining only here and there in the south-west, north-west, and north-east. All that we have here described bears no comparison with the sublime scene presented between 12 and 1 o'clock. Beams of brilliant white light now commenced to shoot up in the south, from the central ring or pole, each being the same distance from its neighbour—the entire column stretching over a space equal to about one-fifth of the entire visible horizon in the form of a fan. The figure rapidly changed from a pure white light, to a glow of brilliant colours of every tint. After three minutes' duration, the variety of colours ceased to exist, and the white flashing radiations again took possession of their place. A number of small meteors, the direction of whose motion was from east to west, appeared a considerable way below the sphere of the aurora. A box containing a magnetic needle, delicately balanced, was exposed upon the ground during the display; but no effect whatever was observed until 10 o'clock, when a considerable amount of deflection was detected. At this time there were dense columns of bright radiating light in the north-west and south-east. The reflection from the columns in the north-west was so clear, that, when made to fall upon the polarizing plate of M. Biot's apparatus, with a film of mica placed upon the stage, the various colours produced by the mica were beautifully and distinctly seen in the analyzing plate.

These phenomena of colours are probably caused by exhalations floating in the atmosphere, between the light of the aurora and the observer, causing a refraction of the rays transmitted to the eye, analogous to that producing the phenomenon of the halo. The continued undulations of the beams of light, and the passing of the rays through thick and thin portions of the vapour, may be supposed to generate the variety of colours. Before the colours were seen, a thin vapour was observed on the west side of the auroral fan, a brisk wind blowing from the west at the time; so that, whether or not the appearance is owing to this movement, it is a fact, that a large quantity of vapour passed between the aurora and the earth. In the opinion of the writer, the origin of the red colour is not identical with that of the observed variety of tints. It has been mentioned that, at a certain period in the course of the aurora, a portion of the dome to the south-west, north-east, and north-west, was of a reddish colour; at that time the moon's position was nearly due east—a cloud moved eastwards, and in its passage came between the moon and the observer. As soon as the cloud had obscured the moonlight, the red colour to the north-west disappeared; but again became visible when an opening in the cloud allowed the rays to pass through, and again vanished when another portion of the cloud cut off the rays. When the cloud had finally passed, the red colour in the different parts of the sky resumed their original tints; and from this fact it may be argued, that when the light of the moon falls at certain angles upon the white light of the aurora, or some kind of vapour that surrounds it, a red colour is produced: hence it is evident, that the moon is, in some way or other, connected with the phenomenon. It is worthy of notice, that the red colour was first observed in the east; and the moon being in that quarter, the rays proceeding from her would first come in contact with that part of the aurora which was towards the east. At the commencement, of course, the moon was far below the visible horizon, having entered her last quarter on the morning of that day. Still, this does not offer any serious objections to the hypothesis in question, seeing that the aurora is at a great height above the earth. According to Dalton, "the region of the aurora is one hundred and fifty miles above the earth's surface."

The splendid spectacle here briefly noted continued six hours, and during that time the thermometer stood at 34° Fahr.

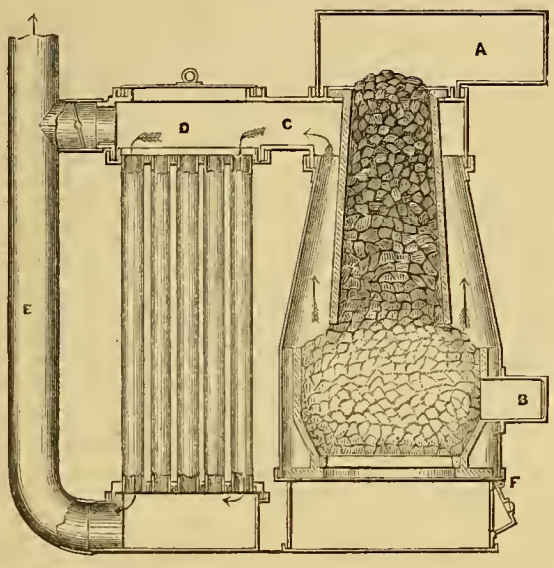
SPILLER AND TAYLER'S WARMING APPARATUS.

The quaint name of "Thermanterion" has been given by the inventors, Messrs. Spiller and Tayler, engineers, of Battersea, London, to an air-warming apparatus, lately introduced by them as a substitute for the hot-

water system. The object of the contrivance is to produce an economical heating effect equal to that of the hot-water plan, without being so expensive—the arrangements being, at the same time, free from the defects of the original warm-air stoves.

Modern warming and ventilating practice has unfortunately been far too often a subject for mere empirical discussion, and even late results, tell very unfavourably for the state of general practical information on the subject;—witness the arrangements at the Houses of Parliament.

The great point in an air-warming apparatus is to communicate the required heat, without, at the same time, deteriorating the quality of the air. By diffusing the furnace heat over a considerable surface, Messrs. Spiller and Tayler have so contrived their heater that the temperature will never rise so high as to burn the air, or injure it in any way for respiration. The accompanying engraving is a vertical section through the centre of the apparatus, as in action. The fuel, coke, is introduced by a door at the top, at A, the fire for lighting being introduced at E. The fuel, when put in at the door, A, falls down an internal central tube, which thus retains a supply for a considerable period, a fresh quantity falling down upon the



fire at the bottom as combustion proceeds. The arrows indicate the direction of the draught. The heated air rises outside the central fuel cylinder, and passes off by the horizontal channel, C, communicating with a rectangular chest, D, which acts as a head for a series of vertical wrought-iron flue tubes. The lower ends of these tubes, again, are inserted in a similar chest at the surface of the ground; and both are in communication with the vertical main flue, E. When the apparatus is in action, however, as represented, the communication between the chamber, D, and the flue, E, is closed by a damper at their point of junction, this channel being merely employed to assist in getting the fire in action by giving the draught a more direct route. When properly lighted, the damper is closed, and the draught is as marked—through the passage, C, and down the tubes, thence into the main flue. A small brass valve is fitted at F for the admission of air to the furnace, and for the regulation of the heat. No bolts are used in the construction of this stove, the whole of the junctions being effected by means of sand grooves; thus every part may expand and contract without risk of fracture; and, in addition, the different portions may be removed at any time with the least possible trouble.

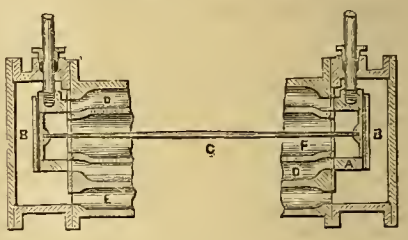
It is intended to burn for 12 or 16 hours with one charge, and may be placed either in a corner of a hall, outside the house, or beneath the floor of the building to be warmed. When placed outside, it is to be enclosed in brickwork, leaving openings for the fuel doors. The cold air is then withdrawn from the interior of the building by an opening near the bottom of the wall, and the warmed air is passed in by a similar passage higher up.

The arrangement is proposed chiefly for buildings in which no provision has been originally made for heating-pipes, or where hot water is not conveniently applicable. It appears to possess all the qualifications of a simple, efficacious, and safe heater. We may, however, remark, that coal cannot be burnt in it, a smokeless fuel being essentially necessary.

ARMSTRONG'S HYDROSTATIC PRESSURE ENGINE.

Future chroniclers will record that, in 1848, a new feature in the application of hydrostatic power made its appearance—that from an elevated pool of water alone, a powerful, steady, and convenient movement was obtained by simple mechanism. In pursuing this valuable subject, Mr. Armstrong, of the Elswick Engine Works, Newcastle-on-Tyne, has succeeded in producing a rotative engine of this class, possessing all the features of docility and aptitude to be found in a modern steam-engine.

Mr. Armstrong's engine has two cylinders placed diagonally with reference to their axes, the connecting-rods of each working upon one crank similar to the arrangement frequently adopted of late years in screw marine-engines. The induction and eduction of the water are effected by slide-valves worked by eccentrics in the usual manner, the ports being of great area as compared with that of the cylinders. The great size of valve would indeed be a serious drawback was there not a provision made for taking off the friction-generating pressure on each slide; and it is here that the chief feature of Mr. Armstrong's improvement manifests itself. Our engraving explains the means he has employed for supplying the defects of all previous inventions, in the management of the influx and escape of the inflexible prime mover. A A, Are the two brass slides, placed opposite to each other. These slides are constructed as open frames, faced on each side, and are fitted on their back with separate brass plates, B B, made water-tight by an overlap of leather. An iron bar or rod, C, extends along the centre of the passage, into which the waste water from both valves is discharged; and this rod abuts against the centre of the inner face of the pieces, B B. D D, Are the passages conducting the water to the top and bottom of the cylinder, the supply being brought along the passage, E, and discharged by the centre one, F.



When the slides are in action, the rod, C, vibrates in the escape passage, and sustains the pressure upon both slides, which are thus relieved of what would otherwise be an intolerable load, and may be set to work with a minimum of friction. The tendency to concussion at the instant of closing the ports is counteracted by a peculiar arrangement of clack valves, which, on the one hand, afford an outlet from the cylinders into the pressure-pipe, at the instant when the shut-up water would resist the motion of the pistons; and, on the other, prevent the formation of the vacuum, which would otherwise form on the opposite side of the piston. By these valves the water is, in effect, rendered elastic; but in order to give additional softness to the action of the engine, a piece of vulcanized India-rubber is fixed at each interior end of the cylinders.

Our two correspondents of last month may perhaps gather from this brief description the desired information as to the secret of Mr. Armstrong's success. The engine mentioned by a "Constant Reader," as seen at the Newcastle Polytechnic Exhibition, was usefully employed in giving motion to a variety of models of machinery. It is of very beautiful construction, and every one agrees as to its remarkable smoothness of movement. Its ordinary speed was 85 strokes per minute; but occasionally it reached 200, without showing any signs of derangement. The water was taken from the street mains. It worked for more than four months, the whole time of the exhibition, with perfect regularity.

Mr. Armstrong, already rendered eminent by his various discoveries, amongst which, not the least is the hydro-electric machine, has in this instance added one more triumph to his list. He has now practically shown that nature's most economical stores of power may be universally applied in the way at which Mr. Taylor hinted last month. A few years more will probably evidence the truth of his proposition. Few places are better suited for a trial of the system than Preston, where a good working head of water is available.*

ON THE ELASTICITY AND STRENGTH OF SPIRAL SPRINGS, AND OF BARS SUBJECTED TO TORSION.†

By James Thomson, Jun., M.A., College, Glasgow.

[Communicated by the Author.]

A Spiral Spring of the most useful kind consists of a long bar or wire, generally of a circular section, coiled up into the form of the thread of a screw.

For the purpose of attaining precision in speaking of such springs, the following definitions and preliminary explanations will be useful. The curve in which the centres of all the sections of the bar are situated, may be called the *spiral axis* of the spring. This lies in the surface of a cy-

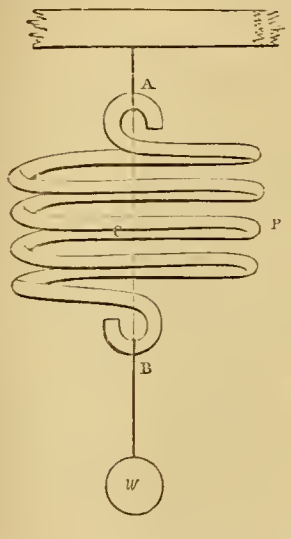
* See Proceedings of the Society of Arts, for the present month.

† From the *Cambridge and Dublin Mathematical Journal*, Nov. 1848.

linder, the axis of which may be called the *longitudinal axis* of the spriug. The angle which the spiral axis makes with a plane perpendicular to the longitudinal axis, may be called the *inclination of the coil* or *of the spiral.* Each end of the bar is bent in such a way that the force applied to elongate or compress the spring may act in the longitudinal axis.* In what follows, nnless the contrary be specified, the spring may he supposed to he suspended by one end, the force applied being one of tension produced by a weight hung at the lower end.

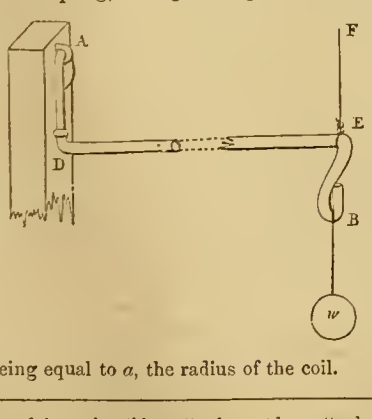
The elasticity and strength of spiral springs have not, so far as I am aware, been hitherto subjected to scientific investigation; and erroneous ideas are very prevalent on the subject, which are not unfrequently manifested in practice hy the adoption of forms very different from those which wonld afford the greatest advantages. Having had occasiou to construct some spiral springs, which, in their elasticity, strength, aud dimensions, should fulfil certain definite conditions, I was led to seek for principles to guide me in determining the forms and dimensions best adapted to accomplish the ends desired.

With this view, the first matter to be considered was the exact nature of the strains which act on the various parts of a spiral spring; and the whole snhject became at once simple, as soon as I perceived that the only strain which produces a sensible effect is one of torsion, acting alike on every part of the coil. To render this clear, let us consider any section P of the har, made by a plane passing through the longitudinal axis, A B. Now, when a weight, w, is suspended at B, the forces transferred from one side to the other of this section consist of a couple whose force is w, and whose arm is the distance, P C, from the centre of the section at P, to the line, A B, together with a force, w, parallel to A B, tending to make the one side of the section slide npon the other in the direction of the longitudinal axis. The effect of this force mnst he extremely small, in fact evanescent, compared to that of the couple; and the force may therefore be neglected, especially when the coefficients for the elasticity and strength of the material are determined in the way which will be hereafter pointed out. The slight deviation of the above-mentioned section of the bar from a circle dne to the inclination of the spiral, may also be neglected in the theory, as the minute influence which it may have, will also he, in a great degree, corrected for by the mode of determining the coefficients.



Let now r be the radins of the bar; l, the total length coiled up; a, the radius of the coil, or the distance from the longitudinal to the spiral axis; w, any weight which may be hung on the spring; e, the elongation corresponding to that weight; and θ, the angle through which a har composed of the same substance as the spring, having its length and radins each unity, is twisted when subjected to a nnit conple. This qnantity θ may he called the coefficient of deflexion by torsion for the substance of which the har is composed.

Let the spiral part of tbe har be supposed to he straightened ont, and let the har be supposed to be placed with one end fixed at A D; and with a couple applied at the other extremity by means of a weight, equal to w, suspended at B, and a force in the linc, E F, equal, parallel, and opposite to that of w; the arm of this conple being equal to a, the radius of the coil.



Now it can be shown that, in bars subjected to torsion, the angle of torsion is proportional to the length of the bar, to the couple applied, and inversely to the fourth power of the radius of the bar. Hence the angle of torsion in the present case, or the angle described by E B, in passing from its natural position to one of equilibrium with the couple wa is $= \theta \frac{lwa}{r^4}$.†

Hence, the space moved over by a point at a distance, a, from the centre is $= \theta \frac{lwa^2}{r^4}$. Now a little consideration will show that this space must he equal to e, the elongation of the spiral spring due to the application of the weight, w. Hence we have

$$e = \theta \frac{lwa^2}{r^4} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1).$$

This equation involves the conditions of the *elasticity* or the *stiffness* of a spring, as compared with its dimensions, and the substance of which it is composed. We will next proceed to those of its strength and its power; or, in other words, we will enter on considerations connected with the greatest weight which it can support, and the space through which it can be elongated without rupture or permanent alteration.

In addition to the notation given above:—Let W be the greatest weight which the spring, if its particles are all relaxed when it is not loaded, can bear without taking a set; E, the greatest elongation, that namely whieh corresponds to W; μ, the utmost couple producing torsion which can be resisted by a bar whose radius is unity, composed of the same substance as the spring, and having its particles at various distances from its ceutre free from mutual opposing straius, when it, as a whole, is subject to no strain. In another paper, "On the Strength of Materials,"‡ I sbowed that the utmost couple which ean be resisted by the bar will vary with the iuternal arrangement of the particles, its greatest value being $\frac{4}{3}$, and its least $\frac{2}{3}$, of its mean value, which, in the bar whose radius is unity, has just been denoted by μ. Any value of this couple, different from the meau one, adapted to a particular arrangement of the particles, may he denoted by μ', and the utmost weight and elongation in a spring having a similar arrangement may likewise be denoted by W' and E'. It will readily be seen that μ is to be regarded as the coefficient for any giveu substance, of the utmost strength of a cylindrical bar composed of it to resist torsion, when the particles of the har have been so arranged that they may be all relaxed when the bar is free from external strain. It must, however, be remarked, that μ would still represent the strength of the bar, even though there were *some* mutual opposing strains among the particles, provided that the particles at the circumference be relaxed when the bar is free from external strain; and that none of the internal particles exist under so great displacements from their positions of relaxation, as to occasion their being strained to the utmost sooner than the particles at the circumference, during the twisting of the bar.

If now, in the formula $L = \frac{1}{2}\pi\gamma r^3$, for the strength of a bar when it is of its mean amount, which was proved in the paper before referred to, we take $r = 1$, L will become what we have denoted hy μ. Hence $\mu = \frac{1}{2}\pi\gamma$, and the formula becomes L or the utmost couple $= \mu r^3$.

Again, since W is the utmost weight, and a the arm at which this acts, the utmost couple may also be expressed by Wa. Hence $Wa = \mu r^3$, and

$$W = \frac{\mu r^3}{a} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2).$$

The greatest elongation of which the spring can admit will be found by substituting in (1), W for w, and E for e.

To justify us in making this substitution, it must, however, be here remarked, that, in ordinarily formed spiral springs, the elongatious continue proportional to the weights added, even up to the very greatest that can be resisted. This fact I have myself observed by an experiment

* In fact, even if, in the construction of the spring, this matter has not been attended to, and the ends of the har forming the points of application of the opposite forces have not been placed in the longitudinal axis, immediately on a tensile force being applied, the spring will, if it be of considerable length, adjust itself so that the force will act in that axis, except in the neighbourhood of the two ends. At those parts the spring will be weaker than towards the middle; and, if the force be sufficient to induce a permanent alteration on its form, this change will commence by the ends assuming forms of greater resistance, tbe longitudinal axis approaching more nearly to tbe line of action of the forces.

† As tbese principles regarding torsion have been laid down in various works on Mechanics and Engineering, I here take them for granted. The methods of deducing them have, however, been insufficient, as it has been, tacitly at least, assumed that all tbe elements in the section of a bar are free from strain when the bar as a wbole is free from external strain; since it is assumed that wben the bar is twisted to any extent less than that which would strain its circumference to tbe utmost, any equal elemeuts of its section undergo strains proportional to the distances of the element.. from the centre. It seldom occurs, however, that the real condition of a bar is in accordance with this assumption; for I have shown, in the preceding paper, that the various particles of materials usually exist under great strains in opposite directions, which are in equilibrium with one anotber The conclusions which had previously been derived are, however, in themselves correct; and in a note to tbe paper just referred to, I have supplied the step which was wanting in the proof, by showing that the angle of torsion of a bar, or in other words its stiffness, is not influenced by the presence or absence of internal opposing strains among its particles; although the case is very different with regard to the ultimate strength of the bar, which is materially altered by changes in those strains. From this it follows, that tbe coefficient for tbe stiffness or deflexion of a bar composed of a given substance has but one value, while that for its ultimate strength may have various values. Of this more will he said in what follows.

[‡ This will be given next month.—Ed. P. M. J.]

conducted with considerable care, and in which any deviation from the foregoing relation which may have existed was less than the inaccuracies of observation.*

Now, by making the substitution above indicated, of W for w, and E for e, in (1), we obtain

$$E = \theta \frac{lWa^2}{r^4} \quad \ldots\ldots (3),$$

which, by (2), may be put in the following form:

$$E = \theta\mu \frac{la}{r} \quad \ldots\ldots (4).$$

The equations (1) and (2) together with (3) or (4) involve the various circumstances connected with the elasticity and strength of ordinary spiral springs. For enabling us to determine, by means of these equations, the actual amounts of any of the variable quantities concerned, when a sufficient number of the variable quantities have been already fixed upon in accordance with the purposes to be effected, the constant coefficients θ and μ for the substance must be determined by experiment.

Without however knowing the actual amounts, we may, by interpreting the equations, arrive at many useful conclusions for the comparison of the properties of springs constructed of the same substance, but having various dimensions. From (1) we see that—

1st. If r the radius of the bar, and a that of the coil, be fixed, the elongation produced by any weight w, will be proportional to l the length rolled up to form the coil.

2nd. If a bar or wire of a certain length and radius be given to form a spring, the elongation produced by a certain weight w, will be proportional to the square of the radius which we may adopt for the coil.

3rd. If the radius of the bar be fixed, and the length of the spring when closed so that the coils may touch one another, or what is the same, the number of coils be also fixed; l must be proportional to a; and therefore the elongation due to a weight w, will be proportional to the third power of the radius which we may adopt for the coil.

4th. If the length of the bar and the radius of the coil be fixed, the elongation due to a weight w, will be inversely proportional to the fourth power of the radius of the bar which we may adopt.

5th. With a given weight of metal and a given radius of the coil, the elongation, due to a weight w, will be proportioual to l^3, or inversely to r^6, since l must be proportional to $\frac{1}{r^2}$.

From (4) we see that the ultimate elongation is,

1st. Proportional to the length of the bar, if the radius of the bar and that of the coil be fixed.

2nd. Proportional to the radius of the coil, if the length and the radius of the bar be fixed.

3rd. Inversely proportional to the radius of the bar, if the length of the bar and the radius of the coil be fixed.

From (2) we perceive that the absolute strength of the spring, being independent of the length, is proportional to the third power of the radius of the bar, if the radius of the coil be fixed; and that it is inversely proportional to the radius adopted for the coil, if the radius of the bar be fixed.

By combining (2) and (4) we arrive at the interesting conclusion, that the "*resilience*" of a spiral spring, that is, the total quantity of work which can be stored up in it, is independent of the form or proportions of the spring, and is simply proportional to the quantity of metal contained in the coil. For, since the weights producing any elongations are proportional to those elongations, it follows that the resilience is $= \frac{1}{2} W.E.$

Hence, by (2) and (4), we find that the resilience is $= \frac{1}{4}\theta\mu^2 l r^2$, which, since θ and μ are constant, is proportional to the volume of the coil or to the weight of metal composing it.

Many other relations might be deduced in similar ways, but those already pointed out will suffice, as others will be readily perceived when they may be wanted, by properly interrogating the formulas.

For determining the values of μ and θ for iron wire such as is commonly used for making spiral springs (called Charcoal Spring Wire), a spring constructed of this material was subjected to careful measurement and experiment, and the following data were obtained:—

Dimensions of the spring $\begin{cases} r = \cdot0023 \text{ inches}, \\ l = 215{\cdot}6 \text{ inches}, \\ a = 1{\cdot}315 \text{ inches}. \end{cases}$

When the spring was successively loaded with weights, each four pounds heavier than the one before, it was found that 56 pounds was the weight which just commenced to produce a permanent elongation, and the elongation corresponding to this weight was observed to be 16·9 inches. By the method which had been employed for bending the wire into the spiral form, and for separating the coils so that they might not press on one another when the spring was unloaded, the wire had been put into the condition which it would have received by having been twisted beyond the original elastic limit, that condition, namely, in which nearly all the particles in its section would come to be strained to the utmost at the same time. Hence, according to the notation which has been adopted, this ultimate weight and elongation must be denoted by W' and E'; which, by the principles given in a former paper, already referred to, will be such that

W' shall be equal to, or rather less than, $\frac{4}{5} W$,
and E' shall be equal to, or rather less than, $\frac{4}{5} E$.†

By taking W', μ', and E' for W, μ, and E in quotations (2) and (3), we get

$$W' = \frac{\mu' r^3}{a}, \text{ and } E' = \theta \frac{lW'a^2}{r^4};$$

From which, by the foregoing experimental data, we obtain

$$\theta = 0{\cdot}000{,}000{,}059‡ \text{ and } \mu' = 94{,}000.$$

But μ' is equal to, or rather less than, $\frac{4}{5}\mu$. Hence

$$\mu = 70{,}000, \text{ or rather more.}$$

The values here assigned to θ and μ will, I think, be found quite sufficiently accurate for all practical purposes; especially as the metal, in other cases, cannot be assumed to be of exactly the same quality as that used in the present one. The experiment from which these values have been deduced is the only one I have as yet been able to make; I hope, however, as soon as circumstances may permit, to carry out a consecutive series of comparative experiments with springs of various dimensions and forms, and of several different kinds of metal, and also to make corresponding experiments by subjecting to direct torsion, bars similar to those forming the springs. In this way would be found the amount by which the coefficients may vary in accordance with different circumstances; and, in applying the formulas afterwards to any particular case, we should be able to choose such values of the coefficients as might appear most suitable; or at least we should know what degree of dependence ought to be placed in results obtained by applying the formulas to such cases. If a spring having the radius of the bar very small compared to that of the coil, and having the angle of its spiral as small as possible, were used, there can be no doubt but that the coefficients so obtained would agree very closely with those deduced from experiment by direct torsion.

Before concluding, I shall now merely remark that, according to the principles already given, spiral springs should always be made of bars of circular section, since such bars have a much greater resilience§ when subjected to torsion than others whose section is different. Thus we see that the rectangular section which has been frequently adopted in large spiral springs for railway carriage buffers is very disadvantageous. It has probably been derived from the idea that the bar is subjected to a transverse strain; an idea which, however erroneous, is the one that usually presents itself to persons considering in a cursory manner the action of spiral springs.

TOD'S CORK-BUFFING AND DRAWING APPARATUS.

This is a most useful and convenient application of cork, as a medium for buffing and drawing carriages, waggons, &c., on railways. It is a desideratum, we believe, successfully supplied, as the forms of buffing and drawing apparatus hitherto applied to the wheeled plant of railways have usually been of such a costly nature, as to preclude their universal application. The tear and wear of ordinary waggons, arising from the want of a cheap, simple, and effective elastic medium for receiving and transmitting concussions, is well understood by those who are conversant with railway matters. It is, therefore, with much pleasure that we introduce

* From this, two distinct conclusions may be inferred:—1st, That the angle of torsion of a bar continues proportional to the applied couple as long as the arrangement of the particles remains unaltered; and, 2d, That the alteration in the form of the spring by the increase of its angle of inclination, and the consequent diminution of the radius of the coil, does not produce a sensible effect. For, were there any deviation from the relation stated in the former proposition, this must in the experiment have been exactly counteracted by an effect of the change of form of the spring, which, it is clear, would have been a coincidence very unlikely to occur.

† If we could be sure that the twisting of the wire, before the experiment, had been sufficiently great, it might be stated with certainty that $W' = \frac{4}{5} W$, and $E' = \frac{4}{5} E$. The uncertainty in this respect, though it cannot much affect the resulting value of μ, is the greatest to which the present determination of the coefficient μ is subject.

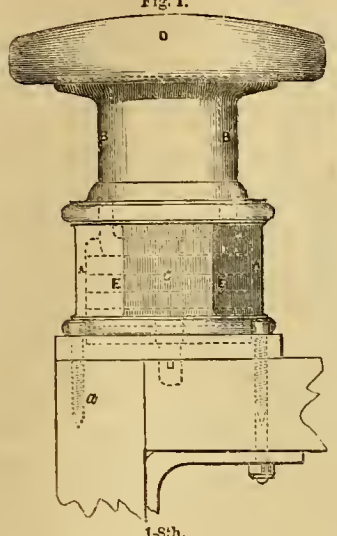
‡ It may here be observed, that for the determination of θ the extreme weight and elongation, W' and E', should not have been used, unless it had been found that these would lead to the same results as any smaller weight and elongation, w and e. It was however found, as has been already stated, that the elongations were throughout proportional to the weights applied; and, therefore, it is a matter of indifference what weight and corresponding elongation we adopt for the determination of θ.

§ The meaning of the term "*resilience*" was before stated to be the quantity of work which can be stored up in the material, by giving to it its utmost change of form.

to our readers the cork-buffing and drawing apparatus, the invention of Messrs. James Tod and Sons, Edinburgh, lately registered by them.

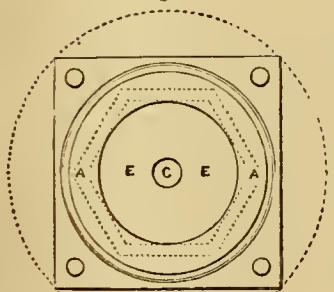
The cork-buffer consists of a box, which may be of cast or wrought-iron, bolted to the frame of the carriage or waggon, and fitted to about half its depth with plates of cork firmly packed into it, and a piston or plunger fitted to slide in the open end of the box, bearing on the cork, and mounted with a buffing block of wood. Fig. 1 is an elevation of a cork-buffer, applicable to a waggon. Fig. 2 is a cross section. A, Is the cylinder, or box, which contains the cork: it is bolted to the under frame of the waggon as shown. B, Is the plunger, which bears upon the cork, being fitted to slide easily in the box. C, Is the guard or guide of the plunger, to retain it in its proper position. D, Is the head of the buffer. E, Is the cork packed into the bottom of the box, A.

Fig. 1.



1-8th.

Fig. 2.



1-8th.

The plunger, on being forced inwards, compresses the cork against the bottom and sides of the cylinder; when the pressure is removed, the cork, by its elasticity, returns the plunger to its original position, the guard pin, of course, checks the plunger at the proper point of its travel, and, by its resistance to the remaining elasticity of the cork, keeps everything tant. It is apparent, from the simplicity of construction, and the material employed, that the buffer is incapable of being damaged by the heavy blows or pressure to which it is exposed in the regular course of traffic. Its small cost is a no less important accommodation. No difficulty can attend the application of the cork-buffers to any description of carrying plant now in use, as they are easily fitted to the waggon-frames, and fixed with either bolts and nuts, or screws. It is obvious that they may be made to any length and compass of spring.

The buffer represented by the drawing is six inches diameter at the plunger, and has three inches of spring. It has been tested to carry a weight of six tons for a period of twelve hours; and, on being released, it returned to its original position. A set of buffers, of the dimensions just given, has been applied to one of the break-waggons employed on the Edinburgh incline of the Edinburgh and Northern Railway. The buffers have been there in operation for some months, during which time the break-waggon has made, on an average, fifty trips per day up and down the incline, and they have not yet shown any symptom of failure or decay,

A simple modification of the apparatus now described adapts it very effectively for *drawing*, which may be accomplished either by separate cylinders bolted to the buffer-beams of the under frames, or by one cylinder at the middle of the frame, to which the draw-rods are coupled.

PORTER'S CORRUGATED WROUGHT-IRON BEAMS.

In the account of the iron Market-house constructed by Mr. Porter for Trinidad, given in our December part, we mentioned that the inventor had introduced the principle of corrugation for beams and girders—trusses or pillars. When used in the manufacture of beams, either a single or a double line of corrugated sheets is used, being held or braced together by a bar of T iron at top and bottom. The following are the results of an experiment tried upon two beams:—

Length of beam between supports, 20 ft. 6 in.; extreme length, 22 ft.; depth of beam, 18 in.; weight of beam, 8½ cwt. The top and bottom frames were of 4 in. × 4 in. T iron, bare ½ in. thick: the corrugated iron was of No. 16 guage, the bands 1½ × ½ in. The two beams were placed 9 ft. apart, and across these were laid two large oak blocks, weighing 1 ton 3 cwt., and supporting the further load. These blocks or bearers (the one 19 in. and the other 24 in. wide) were 4.3 apart from centre to centre, and equidistant from their centre to the centre of the beam, 25½ in.: upon them were laid cast-iron blocks, weighing 6 tons 17 cwt. This weight was put on on Saturday, and remained till Tuesday without causing any deflection. On Tuesday, in the course of an hour and a half, an additional load was applied: 121 bdls. of plate-iron, 7 tons 3 cwt. 16 lbs., producing a deflection of $\frac{9}{16}$ of an inch. This load was allowed to remain from 1 P.M. on Tuesday, until 10 A.M. on Wednesday, in the course of which time the deflection had increased $\frac{1}{16}$. 51 bdls. of plate-iron, 3 tons 9 cwt. 1 qr. 2 lbs., in addition, caused a total deflection of an inch, bare—rested ¼ of an hour. 32 bdls. of plate-iron, 1 ton 18 cwt. 12 lbs., increased the deflections to $1\frac{3}{8}$ and $1\frac{3}{16}$ respectively; the difference was evidently occasioned by the settling down of the piers, giving a greater load to one beam. A further load, 2 tons 8 cwt. 3 qrs., brought the deflections to $1\frac{5}{8}$ and $1\frac{3}{4}$. This loading was proceeded with gradually during three hours, when the load was left for an hour. In the meantime a slight noise called attention to a partial dividing of the bottom flanche of T iron in the beam, which had hitherto appeared the less strained; upon examination, it was found to have originated in a flaw near a "shut" in the T iron, distant 6 ft. 3 in. from the point of support; this caused a further deflection of $\frac{1}{16}$, but the fracture did not appear to increase during half an hour. The deflections of the beams increased to 2 in. and $1\frac{3}{4}$ in. with an additional load, 2 tons 6 cwt. 2 qrs. 22 lbs., applied during three quarters of an hour. After a lapse of ten minutes, a further load, 7 cwt., caused a rapid deflection in the already weakened beam, the corrugated iron giving way at the same time to the strain of the rivets longitudinally. The beams were now blocked up to prevent any accident from the sudden falling of the load. The corrugated iron of the other beam was also found to have yielded to the longitudinal strain of the rivets, principally in the lower part of the beam, from which it appears that they would have fairly broken by tension. The breaking weight being 25 tons 12 cwt. 3 qrs. 24 lbs. taken at or about 25 tons, or, including weight of beams, 17 cwt., at 26 tons 9 cwt. 3 qrs. 24 lbs.

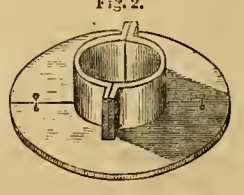
A model beam, to a scale of 1½ to the foot, weighing 3 lbs. $10\frac{3}{8}$ oz. for the 22 ft. and with a bearing of 20 ft. or 30 in., and a depth of 1 ft. 6 in. or $2\frac{1}{4}$ in. bore 112 lbs. suspended from its centre without deflecting. This is equal to a supporting power of thirty times its own weight at the centre. There is little doubt but this would hold good with a full-sized beam.

IMPROVED HORTICULTURAL APPARATUS—ROBERTS' FRUIT TILES AND FLOWER SUPPORTS.

There is a very general complaint amongst gardeners, that they cannot preserve the fruit of strawberries free from dirt in wet weather; the weight of the fruit bears it down upon the earth, and the wet washes up the sand and mould upon it. Mr. Roberts of Eastcheap, London, proposes to prevent this difficulty by the use of what he terms a horticultural double tile and socket, which, when placed round the fruit, will keep it from contact with the earth, shade the surrounding earth from the sun, and prevent the growth of weeds. Fig. 1 shows the mode of applying the tile (in this instance a solid one) to a strawberry plant, the leaves and fruit passing through a cylindrical hole in the centre. The tiles are placed on short feet to allow the wet to run under; and should the plant out-grow the limits of the support, the inventor proposes to retain it by means of a small socket, in two halves, placed as represented in fig. 2, to surround the stem. In this latter instance, the supporting tile is also in two halves, for the purpose of getting it set round the plant without injuring it; a couple of small holes are formed near the edges of the junction of each for the insertion of a small retaining wire.

Fig. 1.

Fig. 2.



Melons and cucumbers, hitherto cultivated only by artificial heat, may, it is stated, be grown much finer in flavour, exposed to the air, by means of square tiles on this principle—no glass being required when the plants are established and planted out. Sockets, from 4 inches to 2 feet high, are also applicable for growing celery—doing away with the necessity of earthing up—as the stems will be perfectly white, whilst they are free from mould.

This contrivance may be adapted for a great variety of plants, and when constructed as an open wire-frame, they answer for supporting flowers. The stems of hyacinth bulbs may be retained erect in this manner, without injuring their appearance.

LOCOMOTIVE PASSENGER-ENGINE "JENNY LIND."

CONSTRUCTED BY MESSRS. E. B. WILSON & CO., LEEDS.

Illustrated by Plate 23.

An account of the gradual improvements in locomotive machinery of the last twenty years, would alone fill many pages of mechanical history. The nature of the work to be done, the variety of circumstance under which locomotive power of great extent is required, and the general demand of the public for a rapid means of transition from one locality to another, have all combined to afford a scope for modifications of construction, hardly to be found in any other branch of modern mechanical contrivances. Year by year additions to the tractive power have been introduced; and refinements have quickly followed one another, bringing with them accuracy of movement, and, above all, speed. A dozen years ago, twenty miles an hour was a tolerably high standard of speed: now, that rate would be deemed a creeping one, and its double is only considered moderate. Again, four or five hundred tons may be frequently seen whisking along behind the heavier class of engines, affording a like example of progress, in comparison with the best performances at the date we have mentioned.

Wherever railways have extended their arms, an increase in the energetic industry of the localities has been invariably manifested; and we could point to many spots, once barren as the desert, where now thriving villages, threatening strongly to swell into towns, have arisen upon the strength of the constructive mechanism of railways alone. Small workshops have suddenly expanded into systematised factories, producing employment for all who have skilled labour to barter.

The establishment whence the "Jenny Lind" took her origin, bears us out in our observations. Two or three years ago, one engine per month was somewhere near its amount of production; whilst at the present date, or lately, 1000 mechanics find employment in it, whose joint endeavours produce seven engines in the same time. The class to which this engine belongs was originated about the beginning of 1848; and in May of that year, a series of experiments*, on the Midland Railway, brought the capabilities of the improved arrangement prominently forward. Plate 23 exhibits a complete longitudinal section of the six-wheeled inside cylinder passenger-engine in working order. Her driving-wheels are 6 feet in diameter, leading and trailing-wheels 4 feet, cylinders 15 inches diameter, stroke 20 inches. Inside fire-box has a heating area of 90 superficial feet; a water space of 3 inches being left between the inside and outside box all round. The cylindrical portion of the boiler is 3 feet 10 inches diameter, and 11 feet long, and contains 148 tubes, 2 inches diameter, giving a heating flue surface of 910 feet, forming, with the fire-box, a total heating area of 1000 feet.

The cylinders are bolted between two inner wrought-iron longitudinal frames, to which are also attached the horn-plates for the bearings of the cranked-axle. In this way the reciprocating strain of the pistons is firmly resisted, without much heavy frame-work. The slide-valves are worked by the ordinary link-motion, by which the steam may be cut off at any point of the stroke, from .75 to .25. The feed-pumps are worked by crank-pins on the outside of the driving-wheels. Next month we shall furnish three additional plates, containing a longitudinal section, and two transverse sections, of the engine, with explanations of the main details.

PROGRESSION OF MACHINERY—THE "TIMES" PRINTING MACHINE.

From the first dawn of the idea of multiplying copies of MS. by impressions of relief characters, to the year 1798, a period of about 350 years, no improvement upon the rude wooden press was introduced; and all the gradations towards the perfection of this wonder-working process have been unfolded in the 50 years intervening between that date and the present. Earl Stanhope set the first example of improvement by his modification, which produced better work, but little, if any, increase in speed. To avoid the loss of time consequent upon the reciprocating movement of these early inventions, Mr. Nicholson, in 1790, patented the arrangement of types upon a cylindrical surface, so as to obtain a continuous circular printing motion. In the inventor's hands, however, this scheme never reached a practical position. König was undoubtedly the first to carry into effect a mechanically-propelled press. He commenced his labours in 1804, and in 1811, after vainly attempting to work a common hand-press by power, he struck upon the idea of the cylinder-pressure machine. The 28th of November, 1814, will ever be a red-letter day in connection with the art; for the *Times* then first informed its readers that the sheet they were reading was the first steam-press printed newspaper. To remove some difficulties in the working mechanism of this machine, Mr. Cowper lent his assistance; and after this time to the present, the successive inventions of König, Donkin and Bacon, and Applegath, have combined to place the art in its present position.

Notwithstanding the hint thrown out by Nicholson with reference to a cylindrical type surface, machines on the model of the great one, with a plane type surface, constructed by Messrs. Applegath and Cowper, have been constantly used by that most colossal of journals, the *Times*. The great size of the sheet has rendered it a most difficult matter to obtain speed with certainty of action. The area of type surface measures 46 × 33½ inches, divided into 24 columns. Up to nearly the present date, this great expanse of types has been formed on a flat surface, being wedged in an iron frame, carried by a traversing table of some 10 feet in length. This type table has a reciprocating motion along a species of railway, and, in its course, it passes first beneath a series of inking rollers, and afterwards under a set of four printing cylinders. The blank sheets are laid on a feeding-board by four boys, two at each end, and a set of endless tapes convey them to the printing cylinders, two of which act upon the type in its forward motion, and two as it returns, giving an impression on one side. An exactly similar machine is thus necessary for printing the other side.

One vital objection in this machine is the reciprocating motion, in which, not only is time lost, but in quick working concussions are inevitable. The moving parts weigh not less than 15 cwt.; and, when printing at the rate of 5,000 copies an hour, the traverse amounts to 6 feet—40 times per minute.

The improvement now introduced by Mr. Applegath, and which has been in successful action since the 3d of October last, consists in a modification of the early idea of cylindrical-surface printing, in which vertical, in place of horizontal cylinders are made use of. The type cylinder is a cast-iron drum, 5 feet 6 inches diameter, with the types built upon it, and placed in the centre of eight printing cylinders of a diameter of 40 inches, the whole being set on vertical axes. Several important reasons have led to the adoption of the vertical-cylinder system, the first of which is the impossibility of making the innumerable loose types adhere securely to the surface of a horizontal cylinder, where centrifugal force acts in concert with gravitation to shake them off. By a vertical disposition of the printing surface, although the centrifugal force is still present, it no longer acts in conjunction with gravity, and therefore the "column rules," or those surfaces forming the straight lines between the columns, are found sufficient as retainers. These rules are firmly screwed to the sides of the "chase," or iron frame of the cylinder, acting as efficient tension-ties, and, being made of a wedge-like section, thicker towards the outer edge, they key the whole area of type firmly down.

A circular gallery, 25 feet in diameter, placed 6 feet from the ground, surrounds the machine, and overtops the sets of feeding apparatus of the eight printing cylinders. This gallery carries eight men, who feed in the blank sheets, which are supplied at the rate of about one in four seconds. Below are eight other men, acting as takers-off of the printed sheets. The type drum is not entirely covered with types, a large portion of its surface acting as an inking cylinder, and working in contact with a set of vertical inking rollers, which in turn give off their ink to the type as the main drum revolves.

The inventor's great difficulty lay in the feeding of the machine, for, in what we have described, it differs little from an ordinary horizontal machine. As the sheets could not be introduced vertically, it became a serious problem how to effect the change from a horizontal, to the vertical printing direction in so short a time as four seconds. The "laying on" is the same as before, each sheet being carried forward towards the cylinders by endless tapes moving at a rapid rate. After travelling some distance horizontally, it is stopped by thin strips of wood placed edgeways, and which come in contact with both sides of the paper at once, at which point it is released from the action of the tapes, and is held at rest in a vertical position between the stopping pieces just referred to. These are then withdrawn, and the sheet is, for an instant, suspended between a pair of small nipping or finger rollers. It now comes against a set of vertical rollers placed between the stoppers, and revolving at a high speed, and by these it is carried sideways towards the impressing cylinder. It was this stage of the operation which caused Mr. Applegath so much delay in the completion of the first machine. The horizontal tapes for giving the lateral movement, pass over and round a set of small drums and rollers, such arrangement having been adopted to avoid the noise and complexity of about 130 small wheels. These drums and rollers are driven by bands and wide tapes, having nothing more to

* "Practical Mechanic's Journal," page 59, Part III.

do than to carry the paper; and owing to the friction, or some unascertained cause, occasional irregularities occurred in the sideward passage of the sheet towards the impressing cylinders, which being geared to the type drum by toothed wheels, necessarily moved simultaneously with it. The speed being about 60 inches per second, a variation in the time of arrival of the sheet of $\frac{1}{60}$th part of a second, made an error of a full inch, and threw the margins wrong. Wheels have since been introdnced, and since then an exact register has been kept.

The impression cylinders are 40 inches in circumference, and each cylinder always touches the type at the same corresponding points, as the surfaces move with equal speed. The blanket is underlaid with slips of paper, and hy the nse of a large diameter of type cylinder, a result has been attained approximating to that given by a flat form of type. That it is not quite so good, is proved in every impression of the *Times*, where, in many of the columns, particularly near the edges of the outer ones, a narrow blank, or imperfectly printed strip occurs. This is what we should naturally have expected from a machine where the surface of the type is unequal, or, in fact, a succession of angles. It would appear that this defect arises from the angles formed hy the column rules, causing the inking rollers to jump, and miss a portion of the form, which is thns deprived of its supply of ink at that part. These imperfections are generally more apparent in the outer columns of each page, where the intermediate space allowed for margin makes the angle greater.

From the great length and complex action of the tapes, and the change of the sheets from a horizontal to a vertical position—the packing of the printing cylinders so as to equalise and compensate the irregularities of the angular form, we should apprehend that many difficultics will occur in the constant working of the machine.

The speed of working has hitherto been about 1,000 revelutions per hour, or 8,000 impressions, and in this respect Mr. Applegath has performed what he promised. The machine is still new, and it is uncertain as to how far the present rate may be increased—but 10, 11, or 12,000 impressions are spoken of. In cases where speed is an object, one machine may be made to give both impressions, as two forms and two type tahles may he placed upon the drum, which, with douhle feeders and takers off, will produce double impressions, or 20,000 per hour. In many respects the vertical cylinder plan has great advantages. For instance, when the sheet of paper is suddenly stopped, any foreign matter shaken from it, falls upon the floor, and not upon the types, so that an impression of 35,000 is worked off without a single hrushing of the form. Again, the ink seldom or uever gets into the spaces or blanks of the types, as its gravity acts in the direction of the plane of their surface.

We may mention that two other machines of a large class have lately been ereeted hy Messrs. Dryden for the *Weekly Dispatch*. These have horizontal cylinders, arranged on the model of Mr. Applegath's four cylinder machine of 1827. They produce at the rate of 5,800 impressions per hour, and work most admirahly. Both arrangements may he classed amongst the wonders of the day. Whether Mr. Applegath will effectually overcome the defect we have pointed out, is yet prohlematical, and perhaps, in the present early stage of the machine's action, it would not be fair to set it dowu as a radical evil.

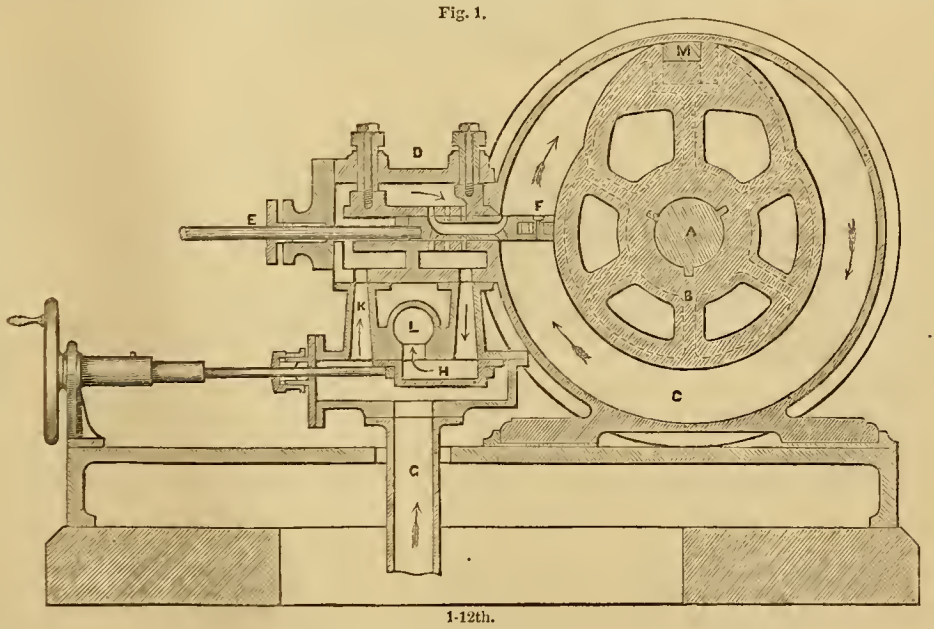
DAVIES' ROTATORY ENGINE.

In the futnre annals of the engineering of the present century, no pursuit, with the exception of the early graspings at the vision of a perpetnal motion, will be found to have attracted so many admirers, as the production of a rotatory engine qualified to supersede the old reciprocating class. It has been the "philosopher's stone" of engineering, the failures in the search of which have, in late years, led to a mass of prejudice against the idea, tending almost to extinguish all enthusiasm amongst the band of practical experimentalists who have devoted attention to the snhject. Our own pages have lately evidenced how contracted have heen the views of even eminent men, in reference to the direct rotatory action of steam.* Since the explosion of the theory fonnded npon the snpposed loss of power in the crank, the advocates of the rotatory system have never sought to set np their schemes hy the downfall of this contrivance—they have only attempted to arrive at its effect by a simpler and more flexible arrangement of mechanism. Without attempting to snbvert the crank, they have endeavoured to establish it in a more convenient form; therefore, the dissertation, "On the Fallacies of the Rotatory Engine," above referred to, and a more voluminous paper with the same title, by another hand still extant, were, to say the least, uncalled for and inapt.

We have long held the opinion, that althongh all attempts at a practical solution of the rotatory problem had most signally failed, yet, comparing the relative excellency of the constructive mechanism of earlier years with that of to-day, there was no legitimate reason for doubting the ultimate snccess of this modification of our prime movers. In examining some of the specimens of the earlier rotatory engines, we find in them numherless unmechanical contrivances which have been resorted to, simply for the reason that the constructive art of the period did not admit of a more finished style, or of a more philosophical disposition of parts. Again, in others, impracticahle notions present themselves in every direction, serving no better purpose than that of explaining how fantastic must have heen the ideas of the unlucky projectors. In the various categories of emission-engines, engines of medial effect, of hydrostatic reaction, and the still more extraordinary nonentities of crank-substitutes, how much room is there for deploring the vast loss of intellectual force occasioned in their development!

Amidst the multitude of incongruities hitherto found in the collections of rotatory mechanism, we have great pleasure in singling out one plan which appears to emhody most, if not all, the perfections theoretically appertaining to its class. The engine in question is the invention of Mr. Isaiah Davies, of Bromsgrove-street, Birmingham, a thoroughly practical mechanic, who, after the experience of a quarter of a century in the construction of the steam-engine in all its phases, has succeeded in practically working out what onr most profound mathematicians have hefore only theoretically demonstrated.

Fig. 1.



1-12th.

Having lately visited Birmingham for the express purpose of examining and reporting upon the merits or demerits of Mr. Davies' invention. we are now enahled to present to the readers of the *Practical Mechanic's Journal* a practical exposition of its actual capabilities. Although the inventor's avocations have chiefly had reference to the ordinary routine of construction of reciprocating engines, he is by no means a modern inquirer into rotatory mechanism, having first patented an engine of the rotatory class in 1844; and the one we are about to describe was constructed according to the plans developed at that period, improved only

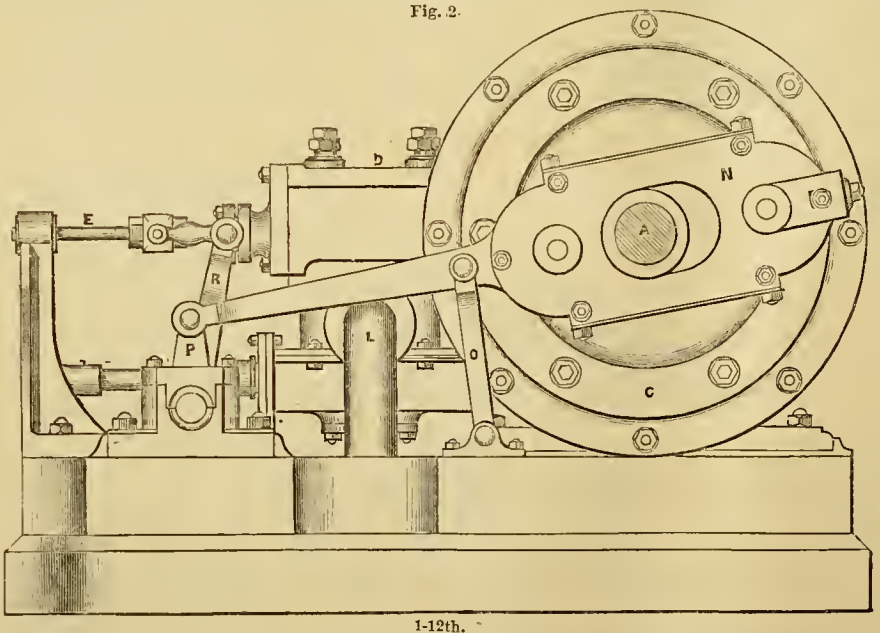
* "On the Fallacies of the Rotatory Engine," by the late G. Stephenson, Esq., p. 138, *ante*. No. 11.

in a few of its details. It has now been constantly at work for a period of fifteen months, driving the wire-drawing and solid-headed pin-works of Messrs. Edelsten and Williams, of George-street, Birmingham; and this duty it has performed for ten working hours daily throughout the whole period, without having in any single instance caused a minute's delay in the operations of the works. Referring to our engravings annexed, fig. 1 is a transverse section of the engine, which is of the duplex construction; fig. 2 is an external end elevation corresponding, showing the arrangement of the cam motion for working the valves; and fig. 3 is a plan view, showing one engine or cylinder, with its appurtenances, in elevation, and the other, together with its valve movement, in horizontal section. A, Is the main shaft of the engine, 5 inches diameter, which both directly receives and transmits the power of the working steam. On this shaft are carried the two pistons, B, set loose on three fixed feathers in the shaft, so that, although they cannot revolve without carrying the main shaft along with them, they have liberty to move slightly in their axial direction. It is here that an eminent objection has been overcome; for this lateral movement prevents all injurious binding and wear of the piston, and, in conjunction with the end set-up plates, allows of the nicest working adjustment of those portions which, in all other rotatory engines, have been found liable to excessive wear—namely, the plane surfaces of the piston and cylinder ends. The two pistons are cylindrical on the greater part of their surface, and have each a projection, of the shape represented in the section, fig. 1, cast on, for the purpose of receiving the actuating pressure of the steam. The diameter of the cylindrical portion of the pistons is 17 inches; and, being placed with their axes coinciding with that of the two cylinders, C C, of 24 inches internal diameter, an annular space of 3½ inches is left between the two surfaces all round. The pistons are each 13 inches deep across the face; and they are so placed on the main shaft, that the projections working up against the circumference of the cylinders stand exactly opposite to each other. The cylinders, C C, are each 15 inches in length; they are bolted down, in the same axial line, upon a cast-iron foundation-plate, carried by a light stone foundation. Each cylinder is flanged at both ends, and the two are bolted together by bolts passing through a central partition-plate, placed between them to divide the spaces of each, the shaft being passed through a central hole in the plate.

The transverse section, fig. 1, explains the valvular arrangement employed for the induction and eduction of the steam. The steam chamber, D, is cast in one piece with the cylinder, having a moveable cover, with adjusting screws for setting a metal plate upon the back of the steam-valve, to take off the pressure of the steam. This valve is worked by the spindle, E, standing out in front of the engine, being actuated by a cam motion of a peculiar nature, which we shall presently describe. The brass steam-stop, F, which acts as an abutment, or moveable partition, upon which the steam re-acts in urging round the piston, is in one piece with the flat steam-valve: the dimensions of which are —length, 13½ inches; breadth, 10½, and thickness, 1½ inches. The peculiar construction of this slide will be hereafter explained, with reference to the detached views of the parts. The supply steam is brought by the pipe, C, which is bolted by flanges to the lower side of a receiving-chest, containing an inverted D, or single cup-valve, employed for stopping or reversing the engine's motion. This valve is worked by a small hand-wheel on a screwed spindle, working into a socket on the spindle of the valve, so that by this means the latter may be set with the greatest nicety to any required point. As now set, the steam passes, according to the indication of the arrows, from the lower valve-chest, up through the uncovered port, K, and thence by the port at the front of the working valve-chest, to the space above the top-plate which bears upon the upper face of the steam-valve. From this point, it passes by the narrow grid-iron slots in the plate, to a similar series of slots in the upper side of the steam-valve, which slots extend across one-half of the valve surface, and communicate with a narrow steam channel cored out of the centre of the valve's thickness, and finally terminating in a larger port, which, in fig. 1, is represented as conducting the induction steam into the cylinder above the end of the valve forming the stop-piece. The exhaust steam is meanwhile returning from that portion of the cylinder which is contained between the back of the projection of the piston, and the lower side of the steam-stop, by an exactly similar set of ports and slots, occupying the remaining half of the valve, as seen more clearly in fig. 3. The main exhaust channel, in the thickness of the valve, communicates by means of three narrow slots in the lower surface of the valve, with a corresponding series in the bottom-supporting surface of the valve-chest, and the steam exhausts thence into a passage, leading into the hollow of the reversing valve, and finally escapes by the exhaust port, L, into a waste steam-pipe, bolted to the side of the stop-valve-chest. It is easy to see how the passage of the steam may be entirely reversed, by setting the reversing valve to cover the front port and open the back one, when the steam will be immediately admitted by what were before the exhaust valves, to that portion of the cylinder below the steam-stop; the exhaust likewise taking the place of the former steam ports on the upper side of the valve. The steam may also be entirely shut off from the cylinder, by placing the reversing valve in the centre of its stroke, so as to cover both ports on its face.

The action of this valve is essentially different from that of the ordinary steam slide-valves, for it has to fulfil conditions of a very different order. It has to remain in one position for a long period during each revolution of the engine, to admit steam to urge round the piston—it must afterwards be quickly withdrawn, merely to allow of the passage of the projection of the piston, when it is again passed inwards as before. For the production of these peculiar movements, Mr. Davies has applied a most ingenious arrangement of cams, which work inside the frame, N, (see the elevation, fig. 2,) in one piece with an actuating rod, partially supported by a link, O, jointed to a stud on the foundation-plate, and finally jointed to a pin in the end of a short lever, P, keyed on the valve rocking-shaft. This rocking-shaft works in pedestals carried by the foundation-plate, and has keyed upon it a lever with a forked upper end, connected by short links to a cross head on the valve spindle, E.

Fig. 2.



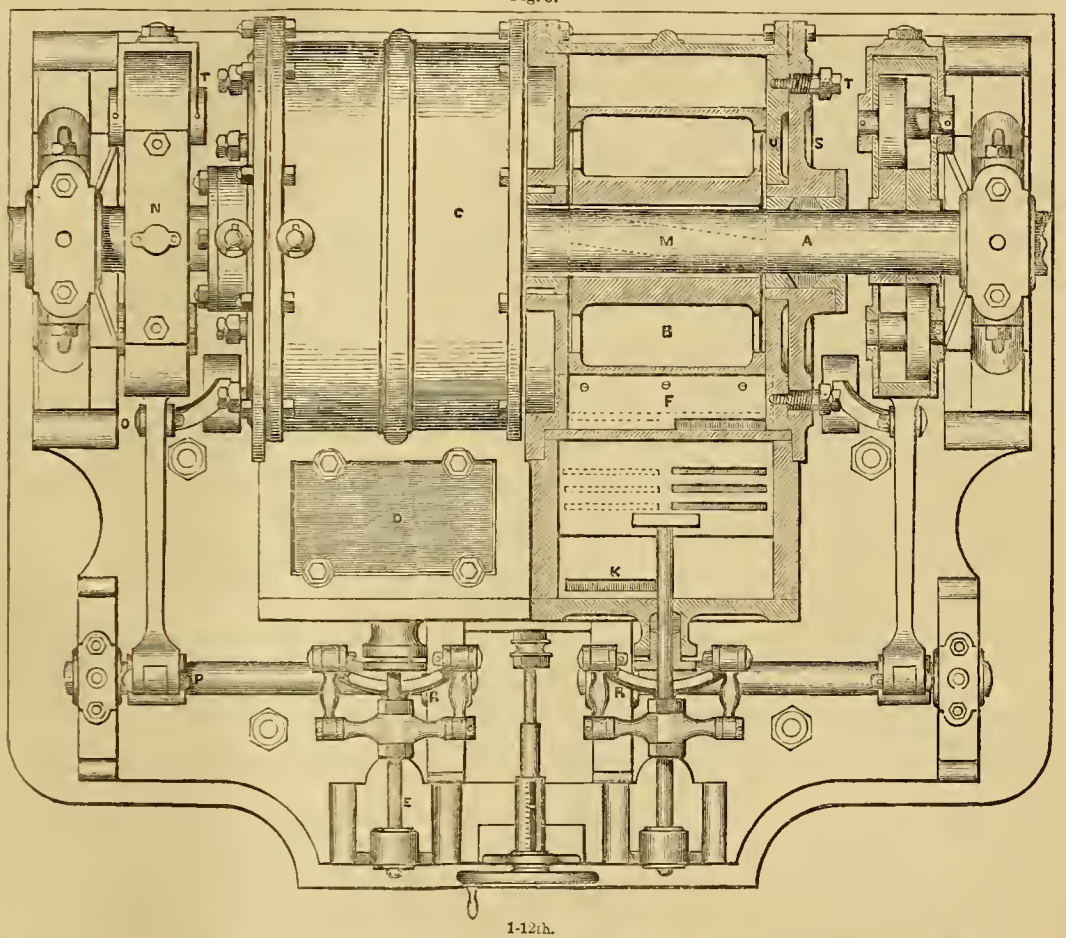
1-12th.

The limits of the present article will not admit of our entering into a full explanation of this motion, which, together with several other details, we shall leave for a fuller elucidation next month.

Again referring to fig. 3, which, as a combined view of the whole engine, gives the clearest explanation of the arrangement, we shall now show how the difficulties attending the end wear of the piston, have been effectually got rid off. A favourite argument of many writers, holding views adverse to rotatory engines, was that of supposing two plane circular discs of metal to be working together, revolving upon coincident centres. Experience had gone to show that the plates in these conditions would inevitably wear untrue, by reason of the much greater space passed through by the circumferences of the discs, as compared with the space near the centre of motion. After working some time, the surfaces were no longer planes, but, by the law of relative velocities, became cones, the centres remaining in contact, whilst the circumferential portions parted. Applying this result to the end wear of rotatory engines, it was held to be

an invincible argument against their success, for the evil only increased by continued working. With the assistance of the horizontal section of one of the cylinders in the ground plan, fig. 3, we shall now explain how this evil does not obtain in the engine under consideration. The end covers are double, the outer one, s, only, being bolted to the cylinder flanges; the inner one is a plain disc nicely fitted to the internal diameter of the cylinder, and faced for the circumferential portion of the piston to work against. This plate is capable of the most accurate adjustment by means of the screws, T T, which are of a peculiar arrangement—two screws, a hollow and a solid one, being employed. A hollow bolt screwed on the outside, is first fitted into threads in the external cover, so as to project slightly through into the interior, and press against the exterior

Fig. 3.



1-12th.

surface of the inner set-up plate, u. Through the centre of this hollow bolt, a solid one is passed, and screwed into the disc, u, by a thread cut for a short distance near the end of the bolt. By this contrivance, the hollow bolt presses firmly against the back of the set-up disc, whilst the inner solid bolt, when turned, pulls the disc tight against the former, and enables the engine attendant to set it accurately, so as to work with the least possible friction on the piston. The latter being cored out, and only a narrow ring of metal being left near the circumference, for frictional wear, the irregularity of wear found in the action of two plain discs of great area is not felt here, as the difference in the distances passed through by the outer and inner portions of the bearing ring of the piston is quite inappreciable.

Fig. 4.

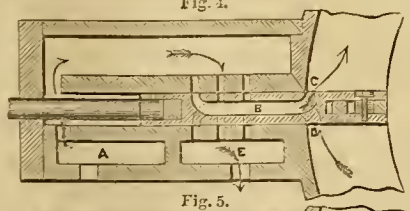
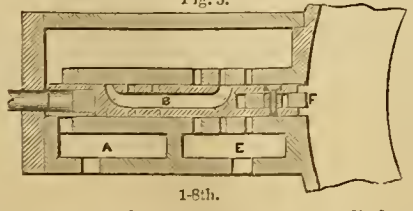


Fig. 5.



1-8th.

Fig. 4 shows the steam-valve and partition slide on a larger scale, detached from the cylinder. In this view, the valve is working under the same conditions as in fig. 1, the steam entering above the partition, and escaping from below it, as therein explained. Fig. 5 exhibits the same valve when withdrawn, to allow of the passage of the projection on the piston, at which time steam is neither entering nor exhausting.

There are numerous ingenious features in this arrangement of valve and steam stop, as the mode of supporting the stop, when exposed to the pressure of the acting steam—the species of sliding piece, which bears upon the cylindrical portion of the piston—and the plan by which a portion of the used steam is shut into the cylinder at the end of the stroke, to be again employed in the succeeding revolution, which we must defer until next month—meanwhile giving the regular performance of the work of the engine, as tested by us.

The main shaft, 6 feet 6 inches in length, 5 inches in diameter, where the pistons are keyed on, and 3½ inches outside the bearing pedestals, is extended by coupled portions to each end of the engine-house, 17 feet. On one end are keyed two pulleys, one 9 inches broad, and 3 feet diameter; the other 6 inches broad, and 2 feet in diameter. The larger pulley has an 8-inch belt, driving a room of pin-heading machines; the smaller one has a 5-inch belt, working a set of scouring machines. On the contrary end of the main shaft of the engine is keyed a fly-wheel, 7 feet 6 inches diameter, weighing 19 cwt., and close to it is an eccentric, working a cold water plunger. 2 inches diameter, and 4½ inches stroke. Behind the fly-wheel, the shaft is coupled to a long line, working a range of wire-drawing blocks.

The working pressure of the steam at the time of our examination was 22½ lbs., the engine making 70 revolutions per minute, with its load upon it. In order to observe and note the consumption of fuel, the slack, burnt from half-past 10 to 1 o'clock (2½ hours), was carefully weighed, and at the latter hour, when the engine was stopped, 2 cwt. had been consumed, leaving a considerably better fire than at starting—thus, under

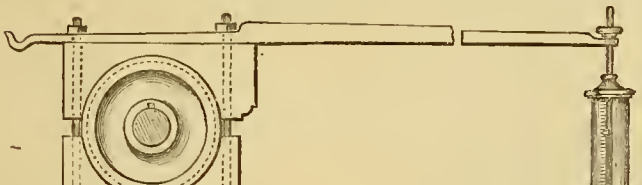
good management, showing a consumption of something less than 8 cwt. per day of 10 hours; and, taking the duty of the engine at 12 horse power, as given by the friction-break, amounting to 7.4 lbs. per horse power of actual duty per hour. In comparing this consumption with that of other engines working under circumstances of a parallel nature, there are two important allowances to be made. In the first place, the actual duty given off at the engine shaft, clear of all deductions for friction, waste, and misapplied pressure, is taken as the measure of consumption, and not the theoretical or calculated power resulting from a given pressure of steam; secondly, the fuel is the smallest description of slack, costing only 5s. per ton delivered at the works—therefore, a set-off must be made in its favour, when comparing it with good engine coal.

According to previous experiments, when working at a pressure of 18 lbs., the evaporative power of the boiler was measured by 9.8 cubic feet per hour, and the coal consumed during this period was 76 lbs.—giving the evaporative power of the slack at 8.06 lbs. of water to 1 lb. Now, according to the recent experiments of the government commissioners,* on the investigation relating to the kinds of coal best suited for the steam navy, the three best Welsh coals, Ebbw Vale, Duffryn, and Graigola, evaporate respectively 10.21, 10.14, and 9.35 lbs. of water from 212°, for 1 lb. consumed. The average of these three gives 9.9 lbs. per 1 lb. of fuel.

Then, by direct comparison, $\frac{9.8 \times 62.5}{9.9} = \frac{61.8 \text{ lbs.}}{10 \text{ hours,}}$ which would represent the amount = 6.01 lbs. of fuel consumed per horse power per hour. We shall not at present enter into any calculations as to the actual amount of steam consumed for a given amount of duty; but, to avoid the intricacy and uncertainty attending what would in the end be nothing more than a mere approximation to the power absorbed by the different ramifications of shafting, and the numerous machines and processes carried on in the works, we shall show what power was really given off under the same circumstances of work and actuating pressure, as represented by De Prony's friction-break.†

This dynamometer is represented in fig. 6. Two of these were em-

Fig. 6.



1-24th.

ployed in our experiments, the cast-iron friction pulleys being keyed on the main shaft, just outside the pedestal-bearings. Diameter of discs, 17½ inches; frictional surface width, 6 inches; length of levers, 7 ft. 6 in. The speed of the engine being kept steadily up to 70 revolutions, its working speed, every 10 lbs. pressure on the ends of the levers, as indicated by the Salter's balance attached, showed 1 horse power. The combined strain on the two balances amounted to 113 lbs., which, allowing .612 horse power for the retarding forces of the breaks not registered on the springs, gives 11.912, or, in round numbers, 12 horse power nearly.

The engine is remarkable for steadiness of working, its proper speed of 70 revolutions being kept with the greatest regularity, although, from the nature of the work upon which it is employed, the resistance varies considerably.

Next month, some of the more important details of the engine will be given, together with the improvements introduced under Mr. Davies' patent of May, 1848, whereby each piston is fitted with two actuating projections, and an arrangement for working expansively is introduced.

W. Johnson.

* See page 51, *et cetera*, P. M. Journal.

† This simple apparatus is to be recommended for testing the power of machines, under almost every circumstance, as it explains to the most uninitiated person the quantity of mechanical power he has at his command, whether his prime mover is a steam-engine, water-wheel, or wind-mill. The principle involved in the instrument is, that in machinery of every kind, some portion of the moving power is absorbed by friction, and this absorber may be so far aggravated in its effect as to consume the whole power at command. Therefore, knowing that all the available power is employed in overcoming frictional effect, it is evident that any means which will correctly measure the amount of such effect will show the true moving power. Reasoning in this manner, M. de Prony, in 1821, devised the friction-break or dynamometer, subsequently improved by M. Egen, who employed it in his experiments, made by order of the Prussian government, upon the hydraulic machines of Westphalia, in 1829. Captain Morin, the celebrated investigator in matters relating to the frictional effects of various substances, used another modification of the break, in testing the power of water-wheels in France. He used a friction-block only on the upper surface of the disc-pulley, the lower bearing surface being a chain of sheet-iron plates. When time serves, we may enter more fully upon the construction and principles of action of this measurer of force.

THE MECHANIC'S LIBRARY.

Builder's Price Book for 1849, twenty-fifth edition, 12mo. 4s. cloth. W. Laxton.
Carpentry and Joinery, Elementary and Practical, 2 vols. 4to. 56s. cloth.
Electricity, "Chamber's Natural Philosophy," 12mo. 10d. cloth.
Electricity, Researches in, vol. I, second edition, 18s. cloth. Dr. Faraday.
Lime, On the Use of, in Agriculture, foolscap 8vo. 6s. cloth. Johnstone.
Logaritbms, Tables of, royal 8vo. 15s. sheep. A. D. Stanley.
Minerals and their Uses, 12mo. 7s. 6d. cloth. J. R. Jackson.
Mines, On the Prevention of Accidents in, 8vo. 4s. cloth. J. Richardson.
Railway Almanack for 1849, 12mo. 2s. 6d. cloth. Bradshaw.
Steam Navigation, Origin and Progress of, 12s. B. Woodcroft.
The Earth, its Physical Condition, foolscap, 4s. 6d. W. M. Higgins.
The Ship, its Origin and Progress, 4to. £2 10s. half-bound. F. Steinitz.
Wonderful Inventions, Boy's own Library, post 8vo. 5s. cloth.

RECENT PATENTS.

RECORDING VOTES AT ELECTIONS.—W. Chamberlain, St. Leonard's-on-Sea.—*Enrolled Dec.* 13, 1848.

This improvement refers to a ballot-box, containing as many horizontal sliding bars as there are candidates. Every bar is in connection with a ratchet apparatus, so that when its knob is touched by the voter, the vote is recorded upon a train of wheel-work: the whole of the bars act as well upon a single ratchet, so as to give the sum of the votes. Contrivances are provided for preventing voters from giving a vote to more than one candidate, or from voting twice for the same party. Each voter is admitted separately to the balloting-room, which is to be lighted sufficiently to enable the party to distinguish the knobs, but not so much as to enable any one to ascertain which bar his predecessor has touched. Claim is the "mechanical arrangements, in combination with ordinary counting or recording apparatuses, whereby an elector may give his vote without its being known to whom, and at the same time prevented from voting for more than one candidate, and giving more than one vote."

FUR FABRICS.—J. P. Westhead, Manchester. *Enrolled Dec.* 13, 1848.—(*Communication.*)

The fine soft short hair of different animals is prepared in the same manner as in the manufacture of hats. It is then carded—formed into slubbings and rovings—spun—and woven as usual with wool. Claims—"1. The causing fur to be prepared, carded, made into rovings or slubbings, spun into yarn, and woven into fabrics. 2. The employment of fur which has been subjected to the process of carroting in the manufacture of yarn."

[This patent having been granted on the 8th of June, 1848, the specification became due on the 8th of December in the same year; but it was not really enrolled until the 13th, or five days after the last day allowed. The invention is therefore lost to the patentee, who, with the idea of saving it, has recited, in his specification, that the grant was on the 13th—such is not the case.—Ed. P. M. J.]

MANUFACTURE OF METALS.—W. Hunt, Worcester, Chemist. *Enrolled Dec.* 13, 1848.

A peculiar reverberatory furnace is proposed for puddling or manufacturing iron, copper, zinc, or the salts of soda, by the adoption of which, coal of low price may be used. Between the bars of the grate and the end of the furnace is a bed, set a little above the level of the grate. At the end of the furnace are two apertures, in which are the rakes, with the interior ends of such a size as to nearly close these apertures when drawn out to their full extent. Above is a perforated air-regulator. Coal is introduced by a door in the side of the furnace, a little above the bed, and clinkers are removed by another door over the grate. Supposing incandescent fuel to be upon the grate, small coal is placed on the bed, and soon becomes partially carbonized and porous; it is then pushed down by the rakes to the grate, and a new supply is introduced. Claims—"The peculiar construction of reverberatory furnaces employed in the manufacture of metals or salts, which provides for the coal to be used, being exposed to heat upon a bed or floor, previously to its transmission

to the grate; and also the regulated admission of air necessary to the combustion of the gaseous products evolved."

ENGINES AND MACHINERY FOR PROPELLING.—J. T. Beale, Greenwich, C.E.—*Enrolled Dec.* 13, 1848.

This invention refers, 1st, to rotatory engines and pumps; 2d, to a combination of reciprocating steam-engine cylinders, and the employment of rotatory pumps in connection with reciprocating engines, and to a frame for carrying the cylinders of steam-engines; 3d, to a propeller and thrust apparatus; and, 4th, to the prevention of incrustation in steam-boilers. We are not told what is new and what is old, nor is any claim made in this document.

ACCELERATED MENATTRITE LOCOMOTION.—J. Miller, London.—*Enrolled Dec.* 13, 1848.—(*Communication.*)

Mr. Miller has here devoted eighteen skins of parchment, and ten sheets of drawings, containing figures of the most extraordinary appearance, to the specifying and claiming of what appears, in our uninspired eyes, to be a series of incomprehensibilities. The reduction of friction, and acceleration of motion, appear to be his objects. Claims are "the application to menattrite locomotion generally, severally, and particularly," of "elastic bearing-wheels, normal vogue paddles, free axle-wheels, apparatus of gravitation, apparatus of transmission, apparatus of collocation, porte-monte (mover-hearer), cutter, cross brakes, pilot, steam propeller, and normal vogue paddles." The terms "menattrite," and "normal vogue paddles," are "unexplained phenomena."

FUEL, FURNACES, GAS, AND CONSUMPTION OF SMOKE. G. Emmott, Oldham, C.E.—*Enrolled Dec.* 16, 1848.

Fuel is manufactured by carbonizing coal in ovens or retorts, which may be entirely or partially closed at pleasure; and this the patentee claims, along with "the application of the gaseous products evolved to illumination, and to the heating of boilers, and of the residuum to useful purposes. The combination of ovens and retorts, with a system of furnace. The introduction of the evolved gas behind the fire-bars of the furnace. The arrangements for consuming the smoke and other gaseous products."

TUBES.—J. Roose and W. H. Richardson, Darlaston. *Enrolled Dec.* 16, 1848.

Tubes for locomotive and other boilers are manufactured by rolling out thick and short cast cylinders of copper, or an alloy of this metal. The embryo tube is placed upon a steel mandril, and passed through rollers suitably grooved, until the desired length and thickness of the tube is obtained. The tube is steadied during the rolling, by rollers placed in front of the reducing rollers. The mandril is afterwards withdrawn by a draw-linch as usual. No claim is made.

OBTAINING METALS.—W. Hunt, Worcester, Chemist. *Enrolled, Dec.* 23.

In this specification, certain modes of obtaining iron from iron slag, copper and tin from copper slag, and sulphate and carbonate of soda from common salt, are described. The iron slag is run into a vessel with a perforated bottom, placed in a pit full of water. This vessel is then raised by a hoist, and the granulated iron is emptied out, and mixed with 25 per cent. of small coal or coal dust. This composition is then put into a reverberatory furnace, covered with coal dust, and submitted to the action of heat for the disengagement of the oxygen, and the conversion of the oxide into a metallic iron; or, after the cementing process, it may be converted into pig or malleable iron in the ordinary way.

In the treatment of copper, instead of skimming off the slag for solidification in masses, it is run into water for granulation; or, in crushing it by mechanical pressure, the ore is first calcined, to free it from sulphur, until the proportion of copper is 60, instead of 35: it is then melted as usual. After separation from the regulus, and reduction to granulation, the slag is mixed with any desulphurizing or deoxidizing substance, such as copper or iron ore; 30 lbs. of copper ore, 40 lbs. of lime, and 20 lbs. of coal-dust being added to one ton of slag, submitted to the action of heat, and lixiviated. Sulphuret of iron, or other cheap sulphuret, may be used in place of the ore, and any other flux than lime. Sulphuret and carbonate of soda are obtained from common salt, by mixing it with artificial sulphuret of iron or manganese, or with proportions of each; or with oxide of iron or manganese, or combinations of these and sulphurous acid, the mixture being heated and subjected to the action of the atmosphere.

MATCHES AND LIGHT.—H. Archer, London. *Enrolled Dec.* 24, 1848.

Mr. Archer's improvements refer—firstly, to modes of manufacturing matches to be used as tapers, which, when lighted, will remain in a vertical position, without trouble, or without requiring any extrinsic support; secondly, to the preparation of hydrocarbons, to prevent any liability to smoke; thirdly, to improvements in night-lights; fourthly, to the construction of pressure-lamps; and, fifthly, to the ornamentation of chimneys, globes, &c. of burners. The matches are made of a conical or cylindrical form, with a central wick, tipped at the upper end with some inflammable substance. To the base is attached a piece of metal, or wood, for the purpose of preventing the melted wax from running off when the match is nearly burnt. Hydrocarbons, as camphine, coal-tar naphtha, are mixed with pyroxilic, in the proportion of one to two by measure, and smoke is thus prevented. The pyroxilic to be varied in quantity, to suit the quality of the camphine. For night-lights, vegetable or animal oils, or camphine, are enclosed in a thin metallic case, with an opening at top, closed by some substance easily perforated by a pin, to allow of the insertion of a waxen wick. In another mode, a taper match, of the before-described construction, is placed in the centre of a glass vessel of oil. In the pressure-lamp, the oil, or other inflammable liquid, is placed in an impermeable flexible bag, which has, at its lower end, a flat disc, fitted to pass easily up and down the interior of the cylindrical base of the lamp. Its upper end has a second disc, furnished with a wick-holder. A coiled spring is placed in the metallic case beneath the oil-bag, which spring, by its pressure, always retains the column of oil at the height of the wick. Chimneys are ornamented by corrugations, either spirally or horizontally. Claims are—"1. Making taper matches, as described, whereby, when lighted and in use, they may be made to stand in a vertical position without extraneous aid, either from the fingers or by fixing the end of the match in a hole in the lid or other part of the match-box, as is usually the case. 2. Preparing camphine, or other hydro-carbons, by mixing them with wood naphtha or pyroxylic spirit, for the purpose of rendering the same more useful for illuminating purposes. 3. Making night-lights in the manner described. 4. Constructing pressure-lamps for burning oil or other inflammable liquids, in which the said inflammable liquids are contained in a flexible bag or case, from which the said liquid is supplied to a wick by means of pressure exerted externally."

LOOPED FABRICS.—F. W. Mowbray, Leicester, Paper Dealer. *Enrolled Dec.* 26, 1848.

The object is to produce looped fabrics at a quicker speed than usual. The cylinder carrying the knitting or looping needles revolves intermittently, the threads being thus laid across the needles. The cylinder then descends, so that the threads take into the beards of the needles; and, by a further descent, the latter are closed, forming the loop. The work is knocked off by the ascent of the needle-frame. Claim is for the combination of the needle-carrying frame or bar, with a thread-carrying piece.

GAS-BURNERS AND CANDLE LAMPS.—R. Clark, London. *Enrolled Dec.* 26, 1848.

The claims being very full and explanatory, we give them in lieu of a general description of the invention:—"1. The several plans described, or any mere modification thereof, for entirely enclosing gas-burners within a glass vessel or chamber, so as to protect the flame from external draught, and cause the air which supports the combustion of the gas to be thoroughly warmed or heated before it arrives at the burner; also, so ornamenting the glass chamber, in order that the metallic part of the burner may be hidden from view as much as possible, yet, at the same time, the passage of the light may not be impeded or its quantity diminished. 2. The various improvements in gas-burners described, and also the improved modes of supporting the chimney and glass shades, and preventing them from becoming accidentally displaced. 3. The method of constructing burners, whereby any irregularity or want of uniformity in the pressure of gas from the mains is prevented from injuriously affecting the flame. 4. Dividing the spring of a candle lamp into two parts, and also adapting the tubular or other piston to the upper part of the spring—one of the objects of both these improvements being to facilitate the placing the spring in the candle tube, after it has been removed for some necessary purpose. Another object of dividing the

spring into two parts, and separating them by discs, is to prevent the melted tallow or grease from getting into and clogging up the lower portion of the spring, which, therefore, need never be removed from the tube. 5. Constructing night-lamps with a curved or hemispherical bottom, so as to cause the melted tallow or grease to drain down to the lowest point, and be consumed. 6. Constructing oil or other lamps in the manner described, or any mere modifications thereof, whereby the flame is or may be perfectly protected from external draughts, and yet be abundantly supplied with air to support combustion; also, the manner of adapting an oil cup to the lower part of the lamp, for the purpose of receiving any overflow: and also, the improved mode of constructing the stuffing-box, as before described, as well as the method of attaching glass handles to spindles for any of the purposes to which such handles may be applicable. 7. Constructing pressure-lamps with a strainer or percolating surface, adapted to or made in the lower end of the supply pipe, for the purpose of preventing any impurities from passing into the interior of the lamp, and clogging it up; also, making a valve or valves in the piston or plunger of pressure-lamps, for the purpose of allowing any air that may have accidentally got under the piston or plunger to escape therefrom; and the method of regulating the supply of oil to the burner, by means of a small plug or screw, by screwing or unscrewing which the capacity of the passage may be regulated at pleasure; and further, constructing pressure and other lamps with short wicks, for the purpose above set forth; also, a support. 8. Regulating the supply of oil to railway lamps by means of a plunger or spindle, whereby the flow of oil may be regulated to a nicety, or stopped altogether, if required. 9. Making lamps or lanterns with reflectors which may with facility be detached from them or adapted thereto when required; and the magnifying, by means of a lens, the rays of light upon the focus of a reflector; and 10. Counterbalancing chandeliers by means of weights enclosed in the tubing which forms the channel of communication from the main to the burners in the case of gas-lamps, and which only serve to support the chandelier when oil is used."

MOTIVE POWER.—J. Macintosh, Glasgow.—*Enrolled Dec.* 28, 1848.

Three varieties of rotatory engines, and a species of flexible valve, are described under this patent. In the first, two concentric cylinders, closed at the ends, are employed. The periphery of the internal cylinder is divided by a central slot, in which the piston-rod travels. The piston, carried by the outer end of this rod, works in the space between the two cylinders, upon the power-shaft passing through them, as an axis. A band of strong flexible material is attached to the interior of the outer cylinder, so as to envelop the circumference of the inner one, with the piston working in the central slot, and is made fast at the two ends, up to the space between the two steam-ports in the outer cylinder. The piston is so set that it shall always keep the part of the flexible band, upon which it is acting, close up against the inside circumference of the outer cylinder. The outer cylinder has a slide-valve, with induction and eduction ports, and the steam enters through it to the space divided off by the band, urging round the piston by its pressure behind it.

The second engine is a reciprocating one, of similar construction, a valve-chest being placed on each side of the cylinder. The third is somewhat like the first: the inner cylinder is dispensed with, and a tube acting as the medium for the impelling pressure of the steam. The steam is admitted by a peculiar flexible valve, consisting of a thin piece of metal attached to the outside of the valve-box, immediately above the steam entry. This piece of metal descends for a short distance, and is then bent upwards, and made fast to one end of a vertical rod, and is supported by a grating.

The tube is made of vulcanized India-rubber, interlaced on the outside with cord. Claims are—"1. In respect to the first and second engines, the use of one or two belts or bands, as described. 2. In respect to the third engine, the use of the tube, and also the flexible valve, as described."

BRICKS AND TOBACCO-PIPES.—*Enrolled Dec.* 30, 1848.

The improvement in bricks consists in forming the faces with an undercut groove, so that a coating of plaster or stucco shall adhere to them very strongly. Those in connection with tobacco-pipes have reference to the processes of preparing the clay, forming the roll, boring and wiring the roll, and firing the pipe. After being soaked in the usual manner, the lumps are deposited in a hopper to be fed into a pair of metallic rollers, one of which revolves three times faster than the other. In this way the material is properly amalgamated without beating. In forming the roll, the clay is forced into a vessel fitted at the end with plates perforated to suit the size of the pipe-stems required, such plates being divided through the centres of the perforations, to permit different quantities of clay, and a larger quantity at the end, to form the bowl. Guides are attached to the clay receptacle, passing through slots in the plates, their heads projecting beyond the slots, as retainers. The proper amount of clay to be used in forming a certain number of rolls, is laid on a bed before the machine, and motion is given by a handle, to a piston carrying a set of opening bars towards the plates, at the same time forcing the clay into the vessel. As soon as the clay emerges from the plates, the points of the opening bars come between the rollers on each side of the machine; as they advance, the plates are gradually opened until the entire stem is formed, when the shoulders of the bars come against the rollers, which are thus opened wide enough to permit the clay for the bowl to escape. The stems are thus formed to the required taper. In another modification, a frame carries a clay-holder, fitted with a piston travelling on a screw. Moulding plates actuated as before are used, and the rolls are forced out in one continuous line. Rolls may also be formed by rollers having suitable indentations on their surfaces; or the clay may be compressed between plates, dies, or moulds.

For boring the rolls, a set of wires placed opposite the holes in the plates are used—so that the clay, in passing, is left hollow in the centre. In wiring, a frame with a number of grooves, corresponding to the number of rolls to be made at once, is provided. Into each of the grooves is laid a wire, with a slider, intended to retain it parallel with the mandrils. The points of the wires are set to come in contact, or nearly so, with the ends of the mandrils, so that when the rolls pass along, they are received upon the wires—and the sliders recede as the rolls advance; the rolls are afterwards finished in moulds as usual, and the wires are withdrawn. Another plan is to lay the rolls in moulds, and force steel wires through them by means of guides.

In firing, the pipes are set on earthenware frames before putting them into the kiln, and the whole frame is then placed in it, so as to facilitate the filling and emptying. Claims are—"1. The making of bricks with undercut grooves on either or both of their faces. 2. The employment in the manufacture of tobacco-pipes, and in the process of preparing the clay—of rollers revolving in opposite directions at different rates of speed. 3. The forming the roll in the said manufacture by the three different modes or processes hereinbefore described; namely, either by forcing the clay through apertures which are made by springs or other equivalent mechanical means, to expand according to the varying thicknesses required for the different parts of the pipe, or by passing the clay between rollers having indentations or matrices on their surfaces; or by compressing the clay between flat dies or moulds; and whatever may be the sort of machinery or means employed in each of these processes, to force or compress the clay between the moulding or forcing surfaces. 4. The employment in the said manufacture of pipe moulds, constructed as before described. 5. The employment in the said manufacture of wires or mandrils to bore the roll in connection with the first of the modes of forming the roll. 6. The method of wiring the roll in the said manufacture, by receiving the same as it passes from the machines, by which it is formed upon wires, having slides or runners, which recede by the pressure of the clay. 7. The employment, in the ordinary method of wiring the rolls, of guides to direct and regulate the insertion of the wire. 8. The employment in the said manufacture of moveable earthenware frames for holding the pipes when ready for firing, introducing them into the kiln, and withdrawing them from the same. 9. The application of the said improvements in the manufacture of tobacco-pipes to the manufacture of all such other articles employed in smoking made from plastic materials, to which the same may, in whole or in part, be applicable."

BANDS FOR HATS, CAPS, AND SHOES.—D. S. Walker, London, Merchant.—*Enrolled, Dec.* 30.

Patentee makes the body of the hat of any tubular woven, looped, or pile-cut fabric, which he stiffens and attaches to a brim and crown as usual. He also applies tubular woven, looped, or pile-cut fabrics, as mourning bands for hats. To the inside of the mourning cloth bands, cut cross-ways, he cements a thin sheet of India-rubber, to make it fit closely to the hat. And lastly, he makes mourning bands of thin sheet India-rubber, by flocking them exteriorly, with any suitable material. The portions of his title respecting caps and shoes are disclaimed, and no special claims are made for any portion of the invention.

WALLS, PIERS, AND BREAKWATERS.—N. Beardmore, C.E., London.—*Enrolled Jan.* 3, 1849.

Mr. Beardmore constructs marine foundations of wrought-iron plates formed into caissons, in conjunction with "filling-up." The bottom of the caisson is divided into cellular compartments by vertical iron plates,

made fast to the bottom, and bent down at the top, to serve as retainers for the concrete or filling-up. Brick or other walls are built up against the interior surfaces of the sides and ends of the caisson, the latter being divided by water-tight bulk-heads. When completed thus far, the caisson is to be floated to the desired locality, and sunk, by admitting water, or with weights; it may then be faced with masonry. The plan is also proposed for the floors and foundations of warehouses. The floor is composed of iron plates riveted together, made fast to the sides of the building, and filled up with concrete. Claims are—"founding walls, piers, or breakwaters, upon a base consisting of wrought-iron plates, arranged and combined with "filling-up." Constructing walls, piers, or breakwaters of caissons, having bottoms, ends, and double sides, made of wrought-iron plates, with a portion of the structure built therein, so as to form, when sunk, a portion of the paramount structure itself. Constructing the floors and foundations of buildings of wrought-iron plates, arranged and combined with filling-up."

ROASTING COFFEE AND MAKING INFUSIONS.—Elizabeth Dakin, London.—*Enrolled Jan.* 3, 1849.

This patent is an improvement upon an earlier one secured by Mr. Dakin, who was accidentally killed in experimenting with his machinery. Claims are—"the employment, in the cleansing and roasting of coffee, of vessels composed of or lined with gold, silver, platinum, or any alloy of these metals. The application and adaptation to cleaning and roasting of coffee, of vessels composed of or lined with gold, silver, platinum, or any alloy of these metals. The employment of a railway and traversing carriage to support the roasting vessel in the furnace, and to facilitate its withdrawal. The employment of a flexible bag or purse in the coffee higgen, which, by screwing, twisting, or pressing, allows the decoction to pass out. The employment of a perforated vessel and piston for expressing the decoction, in lieu of the preceding."

GAS.—J. Robertson, London.—*Enrolled Jan.* 6, 1849.

Claims—"1. The manufacture of gas for illumination from rosin, by mixing it with alkaline and vegetable fibrous substances, and exposing these crude materials to the action of heat in cases placed in retorts, and passing the resulting volatile or gaseous products through retorts, one, two, or more, filled with lumps of coke or lime, or broken brick, or other like materials in a fragmental and incandescent state, as before described. 2. The separation and collection of the oil or oleaginous matters contained in the volatile or gaseous products resulting from the first distillation of the said crude materials, by passing the same through water, as before described. 3. The manufacture from the said oil of an artificial grease, by the admixture of lime and zinc, or some alloy of zinc, as before described. 4. The manufacture from the said oil of a spirit, by the process and the means before described."

AIR-SPRING.—G. Beattie, Edinburgh, Builder.—*Enrolled Jan.* 6, 1849.

Mr. Beattie's air-spring is adapted for closing doors which open both ways. A box is let into the floor, containing a vertical spindle attached to the door; and on this shaft, in a partitioned-off portion of the box, is a toothed wheel gearing on each side, with racks on the rods of two pistons, working in two distinct cylinders. In whichever way the door is opened, one of the pistons is drawn along its cylinder, leaving a resisting vacuum, acting as a spring. The valve apparatus of the cylinders is so arranged, that in case of leakage behind the pistons, the admitted air will be driven out on the return movement. A buffing apparatus is also described. This consists of a cylinder having two other cylinders, arranged concentrically, and in the same line, within it. Each cylinder has a piston attached to the rod carrying the buffer-heads. The inner cylinder has a valved pipe passing through the outer case, for communicating with the atmosphere, whilst the other, or that next the buffer-head, is quite closed. When the buffers are brought into action, the movement of the piston-rod will be resisted by the vacuum created before the piston in the first cylinder, and the compression of the air behind that of the second one. Claims are—"the manufacture of springs for doors or gates, in which the elastic power of air is made to act towards a vacuum. The means of combining buffing apparatus with the joint action of a vacuum and compression of air. Also, the employment of successive chambers to produce vacuum, and of the reaction of the air."

THRESHING AND DRESSING CORN.—W. C. Palmer, Norfolk, Farmer.—*Enrolled Jan.* 10, 1849.

Threshing and dressing machinery are combined in a case mounted on wheels, with a seat for the attendant. Before the seat is placed a portion of a cylinder, made open to allow the grain to pass through, and between the cylinder and the seat a beater is suspended on an axis. Another portion of a cylinder is placed below, joined end to end with the first; and in this a small straw-striker revolves; and in a third cylinder, somewhat similarly placed, a large striker is fitted. Beneath is an endless band for conveying the corn and small straw to a trough, the threshed straw being delivered out at the back of the machine by the large striker. The corn is then raised from its receiving-trough by a chain of endless buckets to a shoot, conducting it to a riddle, which is set at one end on springs, and at the other upon a connecting-rod attached to a crank-shaft. Claims are—"so combining the threshing and dressing-machine, that the corn, as it is threshed out, shall be carried to the dressing-machine; and the employment of the riddle to separate the small straw from the corn, preparatory to its passing into the dressing-machine."

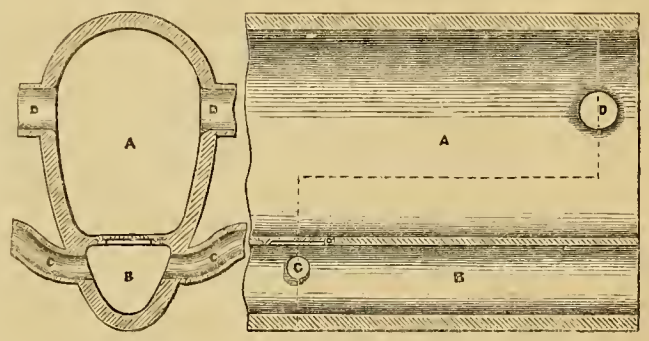
REGISTERED DESIGNS.

DIAPHRAGM DOUBLE SEWER FOR SEPARATING OR COMBINING HOUSE DRAINAGE AND SURFACE DRAINAGE.

Registered for W. B. Moffatt, Esq., *London.*

Our engravings represent, in fig. 1, a transverse, and in fig. 2, a longitudinal section of a portion of the double sewer of the egg form. The

Fig. 1. Fig. 2.



novelty consists in forming it in two separate channels: the upper larger portion, A, acting as a subway for means of access to the lower smaller division, B, and house-drains, C C, as well as for the passage of surface water from inlets, D D. The designer also proposes its use for electric telegraph, gas, or water pipes, so as to obviate the breaking up of the pavement of the streets. It may also be employed as a receptacle and shield for service water or gas pipes for house purposes, by placing them above the level of the inlets, D.

The angular dotted line in fig. 2, shows the direction in which the transverse section is taken, so as to cut through and exhibit the two sets of pipes, and the metal trap, E, which is inserted at intervals along the continuous intermediate floor or diaphragm of the sewer, and may be raised when necessary for cleansing the house-drains and main sewer, or they may be used for flushing with surface water. Protection has been obtained for the diaphragm and trap, as also for the separate divisions of the sewer.

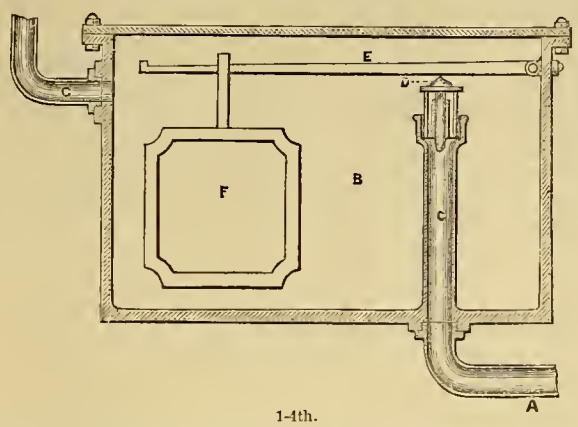
HYDROSTATIC PRESSURE REGULATOR.

Registered for Mr. John Bryce, *Dunlop Street, Glasgow.*

The design protected under this registration will be found most advantageous in all towns supplied with service water at a high pressure. In the pipes of the Gorhals Water Company, for example, where the regular pressure ranges, in different localities, from 50 to 90 lbs., the great pressure often causes serious inconvenience in opening and closing the discharge cocks. If the cock is closed rather suddenly, after running for a short time, a very good exemplification of Montgolfier's ram is given; for the stoppage of the current, causes a tremendous reaction up the pipe, producing a loud cracking noise, and not unfrequently a fracture in some portion of it.

By Mr. Bryce's invention, the greatest initial head pressure may be reduced down to any desired point; so that, if need be, the supply water might be made simply to run out of the discharge-pipe at any level, and in any quantity required. The simple apparatus by which the superfluous head pressure is got rid of, is represented in our engraving, which is a vertical section through the receiving cistern, supply and discharge-

pipes. A, Is the service-pipe, bringing the water supply from the main; it opens into the bottom of the receiving cistern, B, directly beneath a vertical pipe, C, cast on the bottom plate. This pipe is fitted at its upper



1-4th.

end with a small brass valve, D, similar to the safety-valve of a locomotive boiler, except that its face and seat are flat surfaces. A lever, E, is hinged by a stud-bolt to one side of the cistern, and is set to rest upon the conical top of the valve, D; a weight, F, being suspended to it, to give any pressure which may be necessary to counteract the hydrostatic pressure. Suppose this pressure amounts to 50 lbs. per square inch, and the discharge water is required to be reduced down to 5 lbs., all that is necessary is to place the weight, F, in such a position upon the lever, E, that it may press to the amount of 45 lbs. upon the top of the valve, D. The water will now issue by this valve into the cistern until it is full, when it will react upon the top of the valve to the extent of the pressure given by the lever; and the discharge by the pipe, G, will have a pressure no higher than 5 lbs., or, in other terms, it will only rise in the pipe, G, to a height corresponding to this pressure, when it may be drawn off at that point, devoid of all hydrostatic force.

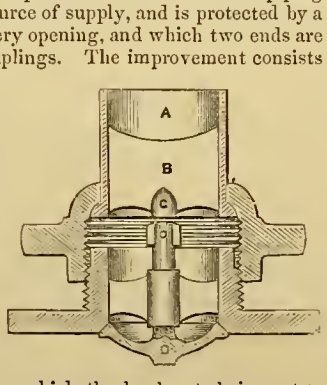
If this apparatus is placed beneath the floor of the basement of a house, the weight may be so set on the lever, E, that its pressure will just cause the water column in the discharge-pipe to stand at a height equal to that of the top, or any other story of the building; or it may be made simply to run out at the level of the cistern itself. A great objection is here overcome by mechanism, so simple as hardly to deserve the name. We cannot give Mr. Bryce too much credit for his contrivance, which, whilst it obviates a troublesome practical difficulty, embodies a new feature in hydrostatics.

The parts which are new, are the whole of the parts as arranged in the design we have engraved.

WATER-VALVE FOR STAND PIPES.

Registered for T. Rontree, *and* A. & R. Brown, *Liverpool.*

Mr. Thomas Rontree, of the Liverpool Water-works, has provided, in this design, a simple and efficacious means of obtaining a supply of water from street and other pipes, at those points where two ends of piping meet, one of which leads from the source of supply, and is protected by a valve, the other leading to the delivery opening, and which two ends are now usually connected by screw-couplings. The improvement consists in inserting in the delivery end of the pipe, A, a mid-feather, B, of the form shown in our engraving. From this mid-feather a small knob, C, projects; and when the pipes are screwed together, this knob presses down the top of the spindle of the inverted valve, D, in the supply end, and admits the water therefrom. A reverse turn of the coupling allows the valve again to close. The mid-feather is applicable to various kinds of valves; and the inventor has shown it also as applied to a hinged flat valve, the actuating spindle upon which the knob acts being set to rest upon the outer end of an arm fast on the valve, which hangs vertically when closed.



The parts of the design which are new, are the parts marked B and C in our engraving.

REVIEWS OF NEW BOOKS.

English Pleasure Carriages: their Origin, History, Varieties, Materials, Construction, Defects, Improvements, and Capabilities. By W. B. Adams. London: Hebert, 88 Cheapside. 8vo. pp. 315. Woodcuts.

British carriage-building has a world-wide fame; every clime possesses specimens of its productions, for in them the highest existing perfections are to be found. Anything, then, emanating from a practical builder, who, like Mr. Adams, stands at the head of his profession, will be valued by practical readers. In this pleasantly-written volume, the author carries us throughout the whole range of the art—from the earliest historical examples of vehicular locomotion, down to the most finished carriages of the present day. One useful feature in the arrangement of the work is the division of the chapters, so as to treat exclusively and separately of defined subjects. Thus, for definition of wheel carriages, materials of wheel carriages, analysis of carriage construction, wheels, axles, springs, &c., separate chapters are set aside.

The great feature of the volume is the description of the author's "Equirotal Carriage:"—

"The author called to mind the fact, that wheels of unequal size in the same carriage were only a proof of defective construction; equal-sized wheels being really the desirable point to aim at. After much reflection, he constructed some models for the purpose of experiment, and ascertained that the lock or turn could be attained much more advantageously, by placing the central pivot or perch-bolt near the centre of the perch, between the front and hind wheels, instead of placing it over the front axle, as is commonly the case. In the common mode, the front wheels lock round on the perch-bolt nearly at a right angle with the hind ones; and in turning, one of the hind wheels serves as a pivot around which the front wheels describe a large circle. But when the perch-bolt is placed at the centre of the total length, in the act of turning, both front and hind wheels lock together, and stand on lines forming the circumference of the circle in which the carriage is intended to turn, the two axles radiating towards a common centre. Thus not only is the circle described by the common carriage larger than the improved one, but the resistance is greater;—in other words, the improved carriage will require less force to turn it. In the common carriage also, as the wheels must necessarily turn beneath the body, they must be kept small. In the improved carriage, with the perch-bolt at a nearly equal distance between the wheels, the fore wheels have so large a radius that they do not touch the body in turning, and therefore may be made of the full size."

The improvement gained by the adoption of equal wheels is too obvious to need any mention; and Mr. Adams has succeeded in applying the principle to all known classes. We have seldom read a practical volume written in so elegant a style as this; for literary excellence is not always united with practical talent. As the inventor of the locomotive passenger-engine, lately engraved by us, Mr. Adams has shown himself to be foremost in a different branch of constructive art, and has led the way in a direction quite untrodden, and now opening up promises of the best success. In "English Pleasure Carriages," we find many valuable practical notes and observations, to which, as opportunity serves, we shall again refer.

Mr. Weale's Rudimentary Works. Geology: by Lieut.-Col. Portlock, R.E. Electricity: by Sir W. Snow Harris, F.R.S. Well-digging, Boring, and Pump-work: by John G. Swindell, R.I.B.A. Assoc. London: Weale. 1849.

These three volumes furnish us with still better grounds for according praise to Mr. Weale for the efforts of which they are the result. Lieut. Portlock's opening page is so much to the point, in reference to the intention of his writings, that we shall reprint it:—

"As it is hoped that this little book may be read by many members of that valuable class of persons who are called practical men, it seems desirable to set before them such reasons as may dispel the prejudice, not unusual on their part, against the men called scientific, and at the same time justify their claim to that proper station in the estimation of men of science, which, as their most powerful auxiliaries, they ought to hold. The mutual distrust between scientific and practical men, though decreasing, does still frequently exist, and is to be ascribed, as in most human differences, to the misapprehension or misinterpretation of a term, which term is in this case 'Science.' What then does the term Science actually signify?—simply Knowledge: but it may be viewed in two different lights, and be understood as implying either

"A Knowledge of Facts, the result of observation; or,

"A Knowledge of Laws, the result principally of combining and reasoning upon facts.

"If these divisions be kept in view, it becomes evident that every human being must make more or less progress in the first branch of knowledge, as it is impossible to live and not to acquire some experience of facts; but that few, in comparison, enter upon the second, which requires, in addition to observation, a power and habit of reflection. And yet it must not be supposed that an exercise of the higher quality of reasoning can dispense with that of observation, as every such attempt has only led to mysticism, and retarded the progress of that real knowledge which in every case proceeds either directly or indirectly from observed facts."

Stripped of its formidable technicalities, so much dreaded by the young student, the primary steps in geology may here be entered upon without difficulty.

In Sir W. Snow Harris's volume, we have all that an electrician could wish for in the small space assigned to the subject. He, too, has done good service in clearing away superfluous matter, and in laying open the pith of the science.

Mr. Swindell's contribution treats of matters which have never before arrived at the dignity of a separate work; its appearance is, therefore, doubly welcome. The different operations of digging, boring, and raising water, are here practically explained for the first time. For the present, we shall conclude our notice with the following extract, worthy the attention of all who may require to bore for water:—

"At Bulphan Fen, within a few miles of Aveley, Essex, is a large tract of grass land, situated low, and liable to be much flooded in the winter season. Its value was little, as in the summer time it was destitute of good water, being wholly dependent upon the pools and ditches which retained the remains of the winter's rain and floods. This rendered it unfit for stock, as, in addition to the small quantity of water remaining, even that was rendered bad by the heat of the weather. The landowners in the neighbourhood were induced to bore, and, being successful in finding springs, the water from which overflowed the surface of the ground, their example was followed by the proprietor of the Artesian well under consideration, who, together with his father, suffered much inconvenience from the scarcity of water upon 300 acres of low grass land at Aveley. A spot was fixed upon at the edge of the uplands, and about the level of high-water mark of the Thames; during the month of August, 1835, the work was commenced. The bore of the auger was 3 inches. The first 5 or 6 feet were an alluvial soil, mixed with many small stones, the whole of a gravelly nature; succeeding this was a very soft, boggy ground, which ran in as fast as bored out; into it was inserted wrought-iron pipe of the usual construction: the thickness of this bog was about 2 feet. The next substance was light brown sand, very close, firm, sharp, and fine; it became darker as the work proceeded, till, at 65 feet from the surface, it was almost black. Separating this sand and the chalk, was a small portion of light, grass green, flaky rock. In the chalk were layers of flints; and the boring was carried on in this formation about 35 feet, when the auger and rods suddenly dropped 7 feet into a cavity of very soft, almost liquid, chalk, from which the water rose to within 1 foot of the surface of the marsh; water had been met with previously, but not in such large quantities as this spring furnished; and, no doubt, the water from this would have risen higher but for its connection with other and weaker springs, which reduced its standing level by abstracting a portion of the water instead of adding thereto, which effect would be owing to the greater hydrostatic pressure of the lower and stronger spring; it must, therefore, always be borne in mind, that, where a great rise of water is wished for from a deep strong spring, all others should be very carefully blocked out; when quantity, and not standing level, is the question, the features of the case are altered. To return from this digression: the water in this well, which, as before remarked, rose almost to the surface, was conducted by a 2-inch pipe, inserted 3 inches under the water-level, into ditches traversing the land; the water ran white for some days, but ultimately perfectly clear, and continues to run night and day. The temperature is 51° Fahr. winter and summer, and the quantity delivered in 24 hours about 30,000 gallons; it supplies two miles of ditches 10 feet wide, from which it runs into the sea.

In the neighbourhood of the above Artesian bore are situated some wells of the ordinary kind; the spring or springs to which they are sunk are strong, the water rising to the same level as in the Artesian one; they receive their supply from the saturated sand spoken of above, and which is situated above the chalk. The identity of level between the wells is, no doubt, owing to their communication, which is established by the water from the chalk rising outside the pipe which lines the bore, the water naturally preferring such an exit to rising higher inside the pipe itself. Even with the most carefully executed work, it is difficult to prevent water rising outside the boring pipes where they pass through sand; therefore, in ordinary cases, such an effect may be expected to take place, unless the lower springs are separated from the upper by an impermeable collar of clay or other matter through which the pipe passes.

CORRESPONDENCE.

RAILWAY SIGNALLING—A WHISTLE FOR THE GUARD.

I am glad to observe, from the various periodicals, that the public mind is becoming more awakened to this important subject; and I trust the time has now arrived, when each railway company will at once agree to adopt some efficient means by which the guard of a railway train can readily communicate with his fellow-servant, the engine-driver, at all times when necessary.

A short time ago, I, amongst others, had the benefit of a practical proof, which pointed out most forcibly this great necessity; and I shall not soon forget the effects of labouring under the fearful sensation of being instantaneously jammed up into an insignificant nonentity by the crushing momentum of a railway train, moving at the rate of 40 miles an hour in a carriage with broken wheels. And although the guard could see the awful position of the passengers, he had no means of communicating with the driver to stop the engine; and we were thus dragged along in this alarming situation, until, from the resistance of the broken wheel and twisted axle against the ploughed-up ballast and splintered sleepers, Goliah's power was subdued, and finally brought to a dead-stand, when we once again blessed our stars for another providential escape.

But this is only one amongst hundreds of cases where the same deficiency has been manifested, and which points out very strongly the absolute necessity of an effective Guard Signal. There may be some directors who yet think very indifferently upon this matter; but only let them once have an entertainment similar to the one above named, and I have no doubt but it will quickly awaken them, and soon stimulate their efforts to adopt every means in their power to secure greater safety, by enforcing more moderate speeds, particularly on quick curves and heavy gradients, and by organizing a better system of railway guards.

The fact is, a guard at present is no guard at all; he is a mere mockery of the name, and must ever remain so, until he has the means of giving efficient signals to those in connection with him. There have been many plans suggested for effecting this desideratum, but very few have been listened to with attention; and now that the subject is forcing itself more directly upon the mind of railway managers and engineers, surely we may expect that this matter will claim their immediate attention, and some simple plan be devised that will prove successful.

Your Birmingham correspondent (p. 212) recommends, with great confidence, the use of a large hand-bell, as the most simple means of giving signals; and, if it would prove sufficiently powerful, I see no objection to his suggestion. But I fear that a hand-bell could not be heard by the engine-driver amidst the noise of rattling wheels and puffing steam, with a long train moving against a strong head wind. However, it may easily be tried; and if not found satisfactory, I beg to suggest the adoption of *a whistle for the guard*. Every body is struck with the shrill and powerful effect of a railway whistle, which can be heard for several miles' distance; and nothing seems better adapted for the purpose of a guard signal than the same apparatus, by the application of *compressed air*.

From this consideration I have been induced to construct a working model, which I have had under observation for several weeks, and I feel confirmed in my opinion, that nothing can answer the purpose more admirably; and if you think this suggestion worth recording amongst the rest, it is at your service. The following brief description of the arrangement will be sufficient for the present:—A cylindrical copper-receiver or air-vessel, say 3 feet long and 12 inches in diameter, is fixed to the back of the guard's carriage, and mounted with a well-constructed whistle, and a small safety-valve, similar to those fixed to the engine. Air is forced into this receiver by means of a small ram-pump, 2 inches bore and 6 inches stroke, which is fixed to the bottom of the carriage, fitted up with suitable valves, &c., and worked by means of a crank on the end of a light counter-shaft. The counter-shaft is placed parallel with the axle of the carriage, and is driven simply by a leather belt or strap passing over a 10-inch drum, which can be easily fastened on the axle by being cast in two halves. The counter-shaft is fitted up with a fast and loose pulley, and a strap fork-lever, by means of which the pump can be readily set in motion, or stopped at pleasure. When the train is set in motion, the receiver can be immediately charged, and any desirable amount of pressure can be obtained, by which the guard may produce from this whistle the same shrill, powerful signals, as those heard from locomotive engines.

When a signal is required, let the pump be first set in motion by instantly putting the strap upon the fast pulley, which will help to maintain the pressure already in the receiver, and the guard having at the same time full command of his whistle, he can immediately produce any desirable number of signals; and, by letting the pump work a minute or two after the signalling is over, it will leave the receiver always charged and ready for action.

W K.

Blackburn, January 13, 1849.

[Air-whistles have repeatedly formed subjects for signalling schemes. Mr. Doull, for instance, patented (Feb. 1847) the application of air-receivers and pumps, to be "worked by hand, or by any other convenient means." In the drawings given by Mr. Doull, the pumps are worked either by hand, through the intervention of a winch-handle on a cranked shaft—or by a pulley fast on this shaft, and driven by a band from any of the moving parts of the carriage. He also showed how, by the combination of two whistles, an intensely thrilling sound might be produced; and also that, with the whistles of different pitches, a regular code of signals might be arranged. For reasons best known to railway directors, this contrivance has never been brought prominently forward—possibly the cost, and the attention required in working the apparatus, have operated against its introduction. We are of opinion that a portable sounding instrument, of cheap construction, as a whistle, horn, or bell, might be contrived for the use of the guard, in calling the attention of the driver to any casualty. But the only really efficient arrangement, is that of forming a series of continuous foot-boards and guide-rails along the whole length of the train, for the passage of the guard to any part of it. The Railway Commissioners have now, at the eleventh hour, approved of a plan of this kind, and we may expect shortly to see it in operation.—Ed. P. M. J.]

HOW TO MAKE TRACING-PAPER.

Observing in a late number of your valuable magazine, that a correspondent requires a receipt for making tracing-paper, I beg to send you the following:—1¾ ounces of Canada balsam, and 1 gill of spirits of turpentine, mixed together, and laid on one side of the tissue paper with a soft sponge. The above quantity will make 14 or 15 sheets of the double elephant size.

M. A. A.

[We have frequently practised this receipt, but never found the paper equal to that to be purchased from the regular makers.—Ed. P. M. J.]

ON THE ANNULAR APPEARANCE OF THE GASES EVOLVED BY THE DISCHARGE OF FIRE-ARMS.

On the diseharge of a gun or musket, with or without a hall, the smoke or gases evolved, frequently assume a heautiful annular or ring-like appearanee, whieh expands itself, and eontinues to do so, as it reeedes from the muzzle of the gun, till lost in the air. This phenomeuon, I have no douht, has heen ohserved hy many of your readers, and some of them may perhaps he enahled to aeeount for its eause; if so, sueh an explanation would be very interesting, I believe, to many who see your exeellent periodieal.

Having thought upon the matter myself, I have adopted a theory in my mind, whieh, I eonceive, may he eonsidered correet; hut, before I venture upon its puhlieation, I should like mueh to hear what may be said en the suhject hy some of your more scieutific eorrespondeuts.

William Taylor.

Preston, January 13, 1849.

ON THE FORMATION OF COAL.

In coneluding the suhject upon the formation of eoal, permit me to oeeupy a few more lines, and to state a few additional faets. The ash of coal eontains no alkalies, but only siliea, alumina, and the oxide of iron. This proves that the alkalies, sueh as potash, originally in the wood, must have heen removed and earried off hy water when the wood was in a liquified state.

The coal formation rests upon the old red sandstone; and, as the old red sandstone possesses the first fossil remains of animal life, so the coal formation presents us with the first fossil remains of vegetahle life. Coal is therefore the first produetion, or the first series of vegetahle formation, whieh were as primitive in their form, as we find the animals were in the first attempts of creative power in their kingdom.

In respeet, therefore, to the alkali not being found in eoal, we must either conform to what we have said ahove, or come to the eonelusion that the primitive vegetahles had no alkali in them. In peat, we find no traces of potash; hut this may he owing to the long maceration that it has undergone in lying up in its hog state.

If iron he the colouring matter of eoal, then iron will always be found in eoal; and such is the faet. Iron may he said to have its primary, secondary, and tertiary states. We find it in its first state in ferruginous granite; sccondly, in the old red sandstone, in trap rocks, hasalt, &e.; and, thirdly, deposited with earhonaceous and aluminous matter. The first stage presents us, we say, with the origin of iron; the second, with the progress it has made, or the first step for a useful development of its qualities; and, in the third and last plaee, we see that end aecomplished. It appears to have heen one prineipal eause of the formation of coal. It has heen made to undergo all these mutations to produce this important end. For when the earth had arrived at that primitive state, that it eould give birth to vegetahle substanees, sueh as would he proper for the formation of coal, iron was required to form that eoal. Sueh were the arrangements of the Great Chemist, that he had provided for the requisite supply of iron in this great lahoratory, that the moment it was required it should he at hand. No sooner is the quantity of vegetahle matter sufficient hy its aeeumulation, than a layer of iron supervenes, and forms over it a roof, whieh, whilst it thus renders the eoal imperishahle, it also, by the wisest forethought, so arranges its position, that it is rendered easily workahle hy man in times far remote from its eonstruetion. As in all other wonders of nature, we see here the wisdom aud foreknowledge of the Great Arehiteet.

But there are other suhstanees found in eoal: these are arsenic and sulphur. We have said there are no alkalies; hut we name this agaiu, heeause it is impossible to eonceive the notion that any vegetahle suhstanee is without alkali. If eoal was formed from vegetahle suhstanees, then the operation of converting sueh suhstanees into eoal must have deprived these suhstanees of all alkalies, and thus we ohtain two results as inevitahle consequenees. 1st, The wood must have been in a state of partial deeomposition and liquefaetiou in order to part with the alkali; and 2d, Water must have been present to eduleorate that matter, otherwise the alkali would he found in eoal. But sulphur and arsenic are found in eoal. These two artieles are the greatest mineralizing suhstanees that we have, and they are the artieles to whieh eoal is indehted for its erystalline form, as in many other minerals. Coal might therefore he called, in one state of its formation, partly a hisulphuret of carhon, mixed with an arseniate of potash, the alkali heing so far retained in this state of the process. Prohahly the arsenic acid was originally arsenous acid; for, taking the wood as we find the constituents of oak, we should have $C_{35}\ H_{20}\ O_{20}$, whilst, if we take splint coal, we have $C_{24}\ H_{13}\ O_0$. The great departure of oxygen from the eoal may be aeeounted for hy its transportation to the arsenous acid, making it into arsenie acid—arsenie acid heing As + 5.0, whilst arsenous aeid is As + 3.0. We may thus see in this a prohahle mode hy whieh the wood lost its oxygen. We do know that hy the aetion of heat and water the alkali and arsenie would disappear,* and scarcely leave a traee hehind them. During this aetion we have the preeise moment when the eoal made or took up its erystalline form. Further, at this time the oxygen of the wood might supply the sulphur in like manner, and make it into sulphurie acid, and thus the minerals, sueh as the iron, whieh we find in coals, would be made into a sulphuret. Sueh results as these are not hypothetieal, hut hounded hy true ehemieal prineiples; they are therefore facts, contingent upon the matters and suhstanees themselves, and are eonsequent upon their union under the apparent eireumstances under whieh they have met together. How the sulphur and arsenie heeame present, it is not our province now to eonsider; but that they were present, and in large quantities, although so small a portion is now apparent in them, is also a faet, heeause they are there still, as the remaiuder or remnants of an operation performed.

It is ehemically true, that wood, iron, sulphur, arsenic, properly set to work, in their hehaviour under proper and fitting eireumstances, would form erystalline coal; nor would it he diffieult to form eoal from sueh an admixture in an artifieial manner. That nature has done it hy proper chemieal aetion is evident—she aets hy no other rule. Sueh laws are therefore the rules to he pursued in imitating her. We ean make earhuret of iron, whieh is indeed eoal, only it has a maximum quantity of iron; and to make earburet of iron with a minimum quantity of irou is indeed to make eoal, the whole matter being only a matter of degree.

Now, Mr. Editor, having occupied mueh of your valuahle time and mueh room in your journal, I take my leave of the suhjeet, leaving your readers to improve or disapprove them; either will he so many steps in the path of truth, after which all disquisitions should tend.

G. R. B.

CONDENSATION OF STEAM.

My attention has lately been direeted to a eireumstance, from which I have dedueed the following question, with a view of submitting it to the readers of your Journal, many of whom will, doubtless, be prepared to answer it in a more scientifie manner than myself.

A close vessel, equal to a eube of 12 inches, is half filled with cold water; and steam of four atmospheres, or 60 lhs. pressure, is then freely admitted to the upper part of the vessel, until the water whieh it eontains is heated to the temperature due to steam of the said pressure. The steam eommunieation is then stopped, and the vessel is allowed to eool to its original temperature. Required—the quantity of water now contained in the vessel.

F. H. P——e.

Holbeck, Leeds, January 17, 1849.

THERMOMETRIC OBSERVATIONS.

In Part 9 of this Journal, a reply appears bearing my signature to a question proposed hy H. R. of Glasgow, respecting wax, whieh question was couehed in terms, the point of which did not admit of a distinct interpretation; that is, it admitted of a doubt whether the inquirer was in seareh of the point of temperature at which fluid wax heeomes solid, or that at whieh solid wax heeomes fluid. My answer was therefore framed to meet hoth eases, as if they were one and the same.

The editor of this Journal prohably deviated from his usual eourse, and properly so, provided the proposer of the question he a person he has reason to respect,—of this I do not complain, but H. R. has given an unfaithful colouring to my paper, and therefore I trust to the urhanity of the editor to allow me spaee in his next Journal for a fair but short self-defenee.

In his original paper, H. R. asks for an exact rule by whieh he may be ahle to determine the true melting point of wax from the ohserved or apparent one. This question, when insulated from the introduction preeeding it, is clear and definite, for it is plain the melting point of wax is required. But H. R., in commenting on my paper, says, "It is quite elear the melting point of a body may he aseertained in either of two ways—viz. hy ohserving the temperature at whieh, when melted, it heeomes solid; or again, that at which it passes from the solid to the fluid state. The query refers to the *former* only, and there is no confounding of the two methods, as Mr. Curr asserts."

* Arsenic is found very abundantly in the strata immediately above the coal.

To this I reply, the *former* is the temperature at which melted wax becomes solid, whilst the question as originally put, and as quoted above, related to the point of melting, which must signify that point at which solid wax becomes fluid. Wherefore I repeat, that H. R. *has* confounded the two cases, and that the question as originally put, and as further explained, can never agree.

I proceed to say, that H. R. having required an *exact* rule for whatever he meant, I took occasion to prove that an exact rule could not he given on any such general question, in consequence of the principle of the thermometric scale not being mathematically correct. The error was shown to 16 places of decimals, and shown exactly, under the supposition that the diameter of the hulb be 1 inch, and the area of the stem a snperficial inch. But the error occasioned by any particular thermometer will vary proportionally to the cubieal contents of the hulh, as compared with the sectiou of its stem. H. R. therefore should have given the respective dimensions of the two thermometers he employed iu the two cases, by which he found different results. Hc has not done so, and consequently the data were insufficient to admit of any other answer than that of taking a mean of two experimeuts, the oue to determine the melting, and the other the solidifying, point of wax, the same thermometer being nsed in hoth experiments.

I do uot perceive why H. R. nnder these circumstances, which if he failed to understand was not my fault, should have twitted me for my minute accuracy and the 16 places of decimals, when showing the exact defect of the instrument; but if the stem had been taken at the hundredth part of an inch in diameter, the error would appear in the third place of decimals; and as philosophers are accustomed to carry out their researches to seven places, I see no reason to repent of my lahour wheu exact accuracy was in requisition.

I have no doubt of having already satisfied the editor that I have safe gronnd for assuming that equal increments of temperature produce equal increments of volume within the limits particularized, and which to economise space in this Journal will not be repeated; but may I be permitted to add, as an egotistical conceit, that I claim the merit of heing the first who has shown the error in the principle of the thermometer arising from the cause described, and that I am under an obligation to H. R. for having afforded me the opportunity of a proof of that which I have heretofore twice asserted in print,—that the contents of the hnlb of a thermometer must be in a definite proportion to the section of its stem.

If H. R. (who has heen elsewhere described as a really clever correspondent of this Journal,) will please to restate his intended question, "force me to a distinct intelligible point," and provide all data requisite to produce an exact answer, it shall he attended to.

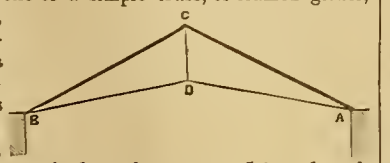
JOHN CURR.

7 *Upper Penton Street, Jan.* 2, 1849.

QUESTION IN FRAME-WORK.

An instance has lately occurred to me, in the course of practice, which has induced me to hand you the followiug prohlem. I imagine the question very simple, as it undouhtedly is to any one accustomed to calculate the various strains existing in a piece of framework; but, simple as it is, it contains something which has puzzled me a good deal. It belongs to a hranch of mechanics which I find very imperfectly understood hy many practical men, although most of onr elementary writers have treated the subject in a very general manner, on account of its simplicity, I snppose, so as to render little assistance to an ordinary mechanic in applying it.

The case to which I heg to direct your notice, and the notice of some of your theoretical readers, is one of a simple truss, or framed girder, similar to the annexed sketch, composed of wrought and cast-iron, constructed to support a load of ten tons npon its summit, the principal dimensions heing as follows:—



Distance hetween supports, A B, 20 feet; vertical height of summit above the supports, 5 feet; length of the suspension rod, C D, 3 feet:—Required, a simple proof of the amount of force acting npon each of the various points.

If you do not consider this too poor a snbject to occupy a place in your Journal, hy inserting it, you will at least oblige the writer, and a few other self-tanght Manchester mechanics, who, like myself, wish to see a simple but general solution.

R. S.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

JANUARY 9, 1849.

JOSHUA FIELD, ESQ. PRESIDENT, IN THE CHAIR.

The first meeting of the session is generally devoted to routine husiness, prefatory of the Annual General Meeting, which immediately succeeds it, and was held on Tuesday, Jan. 16, when the ballot for the election of the President and Council took place.

The paper read was "A Description of the Improved Forms of Water-Wheels," hy Mr. William Fairbairn, M. Inst. C. E. After noticing the opportunity for improvement afforded by the substitution of cast and wrought-iron for timber, in the construction of hydraulic machines, the author pointed out the disadvantages and loss of power attending the principle and the form of the old water-wheels. He quoted Dr. Robinson's "Mechanical Philosophy," for the numerous disadvantages of the old form of hucket, and the difficulties arising from the attempts of the old millwrights to design a shape which should retain the water for a greater length of time in it, and thus give out more power. The chief difficulty was the opposition of the air to the entrance of the water; and numerous contrivances, such as boring holes in the starts, making the spout much narrower than the face of the bucket, &c., were tried; hut still the difficulties existed, and induced Mr. Fairbairn to adopt the construction described in the paper, and which he termed "The Ventilating Water-Wheel."

The general object of these modifications was to prevent the condensation of the air, and to permit its escape during the filling of the bucket with water, as also its re-admission during the discharge of the water into the lower mill-race.

The paper then described minutely the principles and the construction of the large wheels erected for the Catrine and Deanston Works; for Mr. Brown of Linwood, near Paisley; for Mr. Duckworth, of Handforth; for Mr. Ainsworth, of Cleator, and for others; and showed that, in all cases, the system had proved eminently successful.

These wheels were all on the suspension principle, with wrought-iron arms, radiating from cast-iron centres to the periphery, and so placed that the whole structure was in tension, the motion heing communicated from internal toothed wheels, fixed to the shrouding. The various modifications of the forms best adapted for different heights of fall were described; hut it will suffice to give that for breast-wheels for high falls, as it appeared the most complete.

These wheels were described to possess many advantages beyond the overshot, the undershot, or the common hreast-wheels, and were best adapted for falls not exceeding eighteen or twenty feet, and where at times there was a considerable depth of back water; and such was the improvement caused by this system, that the wheel at Mr. Ainsworth's mill was frequently plunged from five to six feet in the back water, without its uniform speed being impeded.

The wheel had a close sole, the tail ends of the buckets were turned up at a distance of two inches from the hack of the sole plate, and running parallel with it, terminated within about two inches of the bend of the bucket, immediately above it. The water, in entering the bucket, drove the air out by the aperture into the space behind, and thence into the bucket above, and so on in succession. The converse occurred when the buckets were emptied, as the air was enabled to flow in as fast as the wheel arrived at such a position as to permit the water to escape.

It appeared to be allowed that this system had been very generally successful, and that the results obtained, had approached, very recently, to the stated duty of the Turbine, whose powers had, however, been much exaggerated, and had been allowed, recently, hy M. Fourneyron, not to have obtained more than ahout 72 per cent. as a mean duty.

JANUARY 16.

The Annual General Meeting was held on Tuesday evening, Jannary 16th, when the following gentlemen were elected to form the Council for the ensuing year:—J. Field, *President;* W. Cubitt, J. M. Rendel, J. Simpson, and R. Stephenson, M.P., *Vice-Presidents;* J. F. Bateman, G. P. Bidder, J. K. Brunel, J. Cubitt, J. Fowler, C. H. Gregory, J. Locke, M.P., J. R. McClean, C. May, and J. Miller, *Members;* and W. Harding and T. Piper, *Associates of Council.*

The Report of the Council was read, and from the statement of its financial position, the Society appeared to be governed by men of foresight, who had very properly restricted the ordinary expenditure within prudential limits, whilst the pressure of the times was felt so heavily hy all classes. It, however, held out cheering hopes for the future, for, as it observed, "in a country like Great Britain, whose distinguishing characteristic is energetic and indomitable courage in circumstances of difficulty, it is not probable that any foreign political excitement can long continue to exercise a prejudicial effect; already the horizon is hrightening, and a little reflection will demonstrate, that in proportion to the injury arising from the late stagnation, must be the activity on the resumption of the works; and it appears to be acknowledged that the forced economy which has been practised during the past year, has caused such a necessity for supplies of working stock, and for the improvement of works, that the Engineering profession must be generally benefited on the return of confidence in financial affairs."

Satisfactory reasons were given for the unusual delay in the publication of the Minutes of Proceedings, and a simple but effective plan was detailed for paying off the debt incurred for the alterations of the House of the Institution.

Telford Medals were presented to the Right Honourable the Earl of Lovelace, Messrs. Harrison, Mitchell, and Ransome; Council Premiums of Books to Messrs.

Harrison and Jackson, and Telford Premiums of Books to Messrs. Redman, Green, and Rankine; the President addressing a few complimentary words to each of these gentlemen on presenting the medals and premiums.

Memoirs were read of the deceased members:—Messrs. B. Cubitt, T. Hopkins, S. Fowls, Members; Lieut.-Colonel Brandreth, P. L. Campbell, F. Carleton, and T. E. Steele, Associates; and J. Pope, Graduate. These contained some very interesting biography, and, as a specimen, we may give that of the late Tom Steele, who was a very old Associate of the Institution.

"Mr. Thomas Ennis Steele was the descendant of an ancient and honourable family in the county Clare, where he inherited a beautiful estate, and few men have commenced their career with brighter prospects. He graduated and took his degrees at Trinity College, Dublin, about the year 1817; he then removed to Trinity College, Cambridge, in 1820, and obtained the degree of Master of Arts in that University, on the books of which his name was always retained, and he regularly appeared at the elections. He was an elegant classical scholar, but more particularly directed his attention to mathematics, mechanics, and the application of chemistry to the arts; he also, at one period, devoted much of his time to the study of geology, with the avowed object of preparing himself for travelling in the East; a project which was probably prevented by his entanglement in politics.

His attention being directed to the bad state of the navigation of the river Shannon, he determined to make a personal survey of the bed of the river, which he did in the most complete manner, employing sometimes very original means; such, for instance, as stepping along the line of a reef or shoal, supporting himself with one hand upon the stern of a boat, whilst he measured and recorded all the inequalities of the surface, and ascertaining the nature of the rock or ground. An account of this survey was published by him; and no greater proof of its utility can be given, than the fact of the greater portion of his suggestions having been followed in the works that have been since executed.

His attention being thus directed to the diving-bell, he devised several alterations in its construction and application; particularly a method of lighting the divers, during their submarine labours. All these, with many similar subjects, were published in the current periodicals of the day, and some of them were communicated to this Institution. At a later period, a favourite theme upon which he repeatedly addressed the Institution, was the purchase of the birth-place of Sir Isaac Newton, and its preservation by the scientific world, in the same manner that Shakspere's house has since been obtained by the exertions of literary and dramatic men.

He embarked deeply in Irish politics, and became the devoted follower of O'Connell, about the year 1825; but upon that portion of his career, the incumbrance of his fortune, and the melancholy termination of the life of a man who might have been an invaluable member of society, this memoir cannot dwell. His political opponents, however, all acknowledged his honourable feelings, and the entire absence of selfishness in all his actions; and in his last hours he had the gratification of seeing the bitterest among them vieing with each other in their anxiety to serve honest Tom Steele.

He was the most chivalrously-minded of men, the most affectionate of friends, and the most devoted of followers, still preserving his independence of mind. He entertained no private resentments which might not instantly be extinguished by the slightest approach to conciliation, even on the part of one who might have deeply injured him; and it may with truth be said, that he never deliberately committed an act by which he thought he should lose a friend, create an enemy, or injure a fellow-creature.

After the decease of his chosen leader, Mr. Steele abandoned politics, and though visibly declining in health and spirits, he steadfastly rejected all offers of assistance from his friends, who desired to cheer the evening of his days; and on the 15th of June, 1848, he expired, a man of fallen fortunes, a crushed spirit, and a broken heart, but universally beloved by all who knew and could estimate the man, apart from the politician."

Votes of thanks were passed unanimously to the President, Vice-Presidents, Members, and Associates of the Council, and to the Secretary; and the President, in returning thanks, gave a memoir of the late George Stephenson, and his connection with the combination of the Fire Tubes and the Blast Pipe in the Locomotive, which constituted it the life of the present railway system.

The following paper was announced to be read on 6th of February—"On the Abbattoirs of Paris," by R. B. Grantham, M. Inst. C. E.

ROYAL SCOTTISH SOCIETY OF ARTS.

AN EXPOSITION OF THE STRENGTH OF MATERIALS AS APPLICABLE TO THE CONSTRUCTION OF CAST OR WROUGHT-IRON BRIDGES.

[Concluded from page 239.]

The great principle of the frame-bridge, Mr. Buchanan illustrated by reference to a small model. It is nothing but a simple modification of the principle of the roof; two rafters meeting in the centre of the bridge, and resting at their extremities on a tie-beam; from this centre the tie-beam is extended longitudinally on each side, and running horizontally to the opposite abutments; and along with it, at regular intervals, a series of rafters, running parallel with each other and parallel with the centre one, are extended the whole length of the bridge; the feet of these rafters rest on the tie-beam; the tops of them cannot meet, but are connected by an upper longitudinal beam running horizontally. On this the rafters are all abutted, and act exactly as if each pair had met in the centre, only that the intermediate connecting beam is subjected to a compressive strain, arising from these rafters all pushing on towards the centre, in the same manner as the lower beam is subjected to a tensile strain from all the feet of the rafters pushing off from the centre. The upper beam is termed the top chord, the lower beam the bottom chord, and the rafters are called the braces; and one member more is only wanted to make the structure complete, namely, a beam or tie standing vertically to connect the top of the one rafter with the foot of the next adjacent, towards the centre; and in this manner every part of the frame is supported, and there being no cross strains whatever, it is truly astonishing how much such a structure will bear. The last-mentioned beam, from being subject to the tensile strain, is termed the tie, and a great improvement has been effected by the introduction of malleable-iron rods in place of timber; by means of this, and of screws and nuts, the whole structure can be brought to a perfect degree of tension, so that every joint and member may bear its due share of the load; and in the case of shrinkage of the timber, or other derangement, the equilibrium and perfect form of the structure can easily be restored and maintained. By screwing up the ties in this manner, the bridge tends to assume an arched form, rising with a camber in the middle; to prevent this, another member has been introduced, termed the counter-brace, which is a beam of timber, extending from the top of one rafter to the bottom of the next adjacent, from the centre towards the extremities of the bridge. This counter-brace crosses the braces, and resists any change of form which the screwing up of the rods would bring on; and there is this remarkable advantage obtained, that the action of these counter-braces, thus screwed up to a certain degree of tension, prevents the weight of the passing loads from having any effect in straining or deflecting the bridge. Instead of any additional strain on any part, these loads rather relieve the counter-braces from the tension to which they are subjected. No deflection or change of form can occur, except what may arise from the mere compression or distention of the parts, and these being all strained end-ways, and there being no cross or oblique action, this effect is absolutely nothing; and the form of the structure and strains on it become in a great measure, if not entirely, independent of the fluctuating traffic. The bridge is already strained to the utmost extent of any passing load, and cannot be affected by it; whence arises a principle of stability and safety well worthy of consideration, particularly in the case of railways. The strength and stiffness of the small model was then shown, and the enormous load which it carried; and the whole of this interesting subject was concluded by the exhibition of a much larger model of one of the American bridges. Bridges of so great a span as 200 feet are common enough in that country, and the model represented one of these. It was exactly $\frac{1}{10}$th of the dimensions, being 20 feet long, and the frames on each side 2 feet deep, consisting of the top and bottom chord, 1 inch by $2\frac{1}{2}$ inches; the braces in pairs, $\frac{3}{4}$ of an inch square; the tie-rods in pairs, $\frac{1}{4}$ inch diameter; and the counter-braces each single, $\frac{3}{4}$ inch square. One of these frames was placed at each side of the bridge, connected at the bottom by cross beams, on which was laid the planking of the roadway. The whole weight of the bridge was only 113 lbs., and although 20 feet span, and of such slender materials, it carried six persons, equal to at least 7 or 8 cwt., standing on the centre, without deflecting more than $\frac{1}{4}$ of an inch.

Another advantage he also mentioned of these bridges, was the simplicity of construction; the braces and counter-braces were all cut exactly to the same length and square on the ends; no morticing or jointing of any kind, but resting simply on blocks attached to the top and bottom chords, through which blocks were also passed the tie-rods. Nothing could be simpler, and the whole bridge could be taken down, removed to another site, and there put up with facility. It is easy to see also, that as the malleable-iron ties have been substituted for the upright timbers, so may it be for the bottom chord; and the braces and counter-braces could be made of cast-iron in the form of hollow square tubes, which would altogether form an extremely simple and strong girder or bridge. One remark, however, he must make regarding all these bridges or girders of a rectangular form, namely—that though they may be practically convenient in many respects, they are all attended with a sacrifice of material, in so far as they deviate from the principle of the arch. The top chord might be in the form of an arch, starting from the level of the roadway at the abutments, and rising to the original height at the centre. In this way much material would be saved, while the strain on the chord would be greatly less, owing to the curvature; and this form is often used in America, but not combined with the principle of the braces and counter-braces as it might be. The same remark applies also to the iron tubular bridges, which possess advantages in simplicity and great steadiness, but no doubt the material at the ends is redundant, and the strain in the centre beyond what would occur in the case of the arch. He now begged to conclude these expositions, which had been extended to much greater length than he had anticipated.

Professor Forbes said, that in regard to these American bridges, which appeared to possess peculiar properties, he would put a question or two, which Mr. Buchanan might probably answer, namely, how far they did not resemble in principle the iron tubular bridges of Mr. Stephenson? The framework in the model of the American bridge at the sides was no doubt open; but he observed, from the drawing, that there were double the number of frames as there were in the model; and he understood that the sides were often formed by numerous little lozenges, or lattice-work, forming nearly a continuous web; and he should like to know, whether the sides of the tubular bridge, with the angle irons to strengthen them, did not much resemble this web of lattice-work? In regard to the top and bottom also, it appeared from the model that those also were united by diagonal beams or frames, forming a sort of enclosure at top and bottom, and as the side frames were twenty feet in height, this left ample head-room for passengers and carriages.

Mr. Buchanan replied, that the resemblance in principle to the tubular bridges had struck himself forcibly in considering these structures. The top and bottom chords of the former answered to the cellular tubes in the roof and floor of the latter, and the frames on each side to the iron plates, forming the sides of the main tube, with their numerous angle iron pieces, which were laid on the continuous ground of the plates to give stiffness to the sides. The frames of the American bridges were also connected at the bottom by cross frames and timber planking; and at the top, he believed, they were also, in some cases, connected in a similar manner, and

covered in by a roof, for protection against the weather, so as, on the whole, to form, as it were, a complete rectangular tube in skeleton. Still, however, the tubular bridge was, in many respects, a very different structure; and the design of a bridge, of one vast malleable-iron tube, was an idea at once happy and original, and was, he considered, due entirely to Mr. Stephenson.

Mr. Buchanan having explained, in regard to the tensile strength of malleable-iron, stated at 27 tons for the breaking weight, that this was from the old experiments of Telford, Brown, and Rennie, Professor Forbes said he understood from Mr. Stephenson that he considered this result too high. Mr. Buchanan stated that he was not aware of this; but he knew Mr. Stephenson had taken the safe load of malleable-iron of the Tyne bridge at 9 tons, which was rather larger than Mr. B. had been used to calculate, so that the final results were very nearly the same. He would, however, endeavour to obtain Mr. Stephenson's results accurately.

The following is the Report of the Prize List for 1847-8:—

1. To George Buchanan, Esq., for his description of a 'Marine Hydrometer,' for ascertaining on the spot the comparative saltness or freshness of sea and river water. The Honorary Silver Medal.—2. To Andrew Fyfe, M.D., Professor of Chemistry in King's College, Aberdeen, for his communication 'On the value of Gases from different coals, and the price of light in different places; also, a new mode of estimating the consumpt of Gases, &c., and of estimating illuminating power.' The Honorary Silver Medal.—3. To J. Stewart Hepburn, Esq. of Colquhalzie, for his description and drawing of an 'Improved Railway Break.' The Honorary Silver Medal.—4. To Thomas Stevenson, Esq., civil engineer, Edinburgh, for his description, drawing, and model of a 'Portable Cofferdam,' successfully used by him in marine works.* The Honorary Silver Medal.†—5. To Mr. John M'Dowall, engineer, Johnstone, for his description and working model of a 'New Machine or Screw Pump for Lifting Water.' The Silver Medal or Plate, value Fifteen Sovereigns.—6. To Mr. Robert Montgomery, cotton-spinner, Johnstone, for his description and model of a 'Self-acting Safety Break for Railway Carriages.' The Silver Medal, value Ten Sovereigns.—7. To Mr. William Kemp, manager of the Gas-works at Galashiels, for his communication 'On Economizing Fuel in Gas-works.' The Silver Medal, value Ten Sovereigns.—8. To Mr. Frederick Schenck, lithographer, Greenside-street, Edinburgh, for his communication 'On the progress and position of Lithography in Scotland,' and in particular, his method of preserving correct register in colour-printing. The Silver Medal, value Six Sovereigns.—9. To Mr. Daniel Erskine, plumber and gas-fitter, &c., Clerk-street, Edinburgh, for his description of a 'New Ball-cock and Nose-cock,' for cisterns and other purposes. The Silver Medal, value Five Sovereigns.—10. To Mr. James Robb, Haddington, for his description and model of a 'Stop-cock for Corrosive Fluids.' The Silver Medal, value Five Sovereigns.—11. To Mr. John Kolbe Milne, 33 Hanover-street, Edinburgh, for his description and model of an 'Overarch Suspension Bridge.' It being understood that it is recommended in its present form not for railway bridges, but for foot bridges and others of comparatively small span. The Silver Medal, value Five Sovereigns.—12. To Mr. Alexander Nicoll, Dishlandtown, Arbroath, for the ingenuity displayed by him in a description, drawing, and model of a 'Jumper for Boring Rocks and loose Stones, to be moved by mechanical power.' Three Sovereigns.—13. To the same, for his description and model of a 'Proposed Improvement of Railway Switches.' It being understood that this is considered an improvement only in sandy districts, when the common switches would be impeded in their operation by the blowing of the sand. Two Sovereigns.—14. To Mr. Andrew Mennie, Castle-street, Forfar, for the ingenuity displayed by him in his proposed method of preventing the vertical oscillation of spring carriages on railways. Three Sovereigns.

The Committee recommend, that while the thanks of the Society are justly due to all those gentlemen who have sent communications, the special thanks of the Society be given to the following gentlemen, viz.:—

1. To Mr. James Robb, Haddington, for his attempt to introduce a 'Malleable Iron Railway Chair.'—2. To Grant S. Dalrymple, Esq. F.R.S.S.A., Civil Engineer, late of Edinburgh, now of London, for his 'Suggestions as to the possibility of a more extended application of Electrical Combinations to Mechanical and Domestic purposes.'—3. To G. M. Scott, M.D. 80 Bath-street, Glasgow, for his 'Description and Drawing of a Method of rendering the Ordinary Articles of Ship-Furniture available as Life-Preservers.'—4. To Mr. Andrew K. Sparke, Devonport, for his 'Account of the Method of making the Brush Hat, much worn on the Continent, and in America; and on an improved Material for making the Bodies of Stuff Hats.'

The Committee beg to observe, that the important information given in this paper would have entitled Mr. Sparke to a valuable prize, except for the circumstance, that the information is now of no practical value, owing to the almost universal preference given to the silk hat.

No reports have yet been given in on Mr. Sparke's 'Transfer of Talbotype to Stone,' or on his 'Plate-holder for the Dagoerreotype Camera.'

The Committee recommend, that as the following communications were not read till the very last meeting of the session, they should still be remitted to committees to report upon them, viz.:—Mr. D. Campbell on the Manufacture of Writing-Ink, and Mr. Robert Scotland's Chimney-Can. The further consideration of these papers is therefore postponed till next session.

In conclusion, your Committee regret that there has been no communication read during the past session, to which it seemed proper to award the Keith Medal of Thirty Sovereigns.

* See Practical Mechanic's Journal, p. 103; also, p. 137.

† Though unknown to Mr. Stevenson, the committee find that a Portable Cofferdam, with double walings, had been previously used in engineering works by the late Mr. Smith of Montrose, which was put together on dry ground, and then floated to its place. But the committee consider that Mr. Stevenson's Cofferdam differs from it, and possesses certain advantages, from its greater portability, and more ready adaptation to an irregular bottom.

27th November, 1848.

John Cay, Esq., F.R.S.E., President, in the Chair.

The following communications were made:—

1. Description, with two drawings, of an Hydraulic Dock, especially adapted for places where there is little or no rise and fall of the Tide. By Mr. James Scott, carpenter, 15 Broad Wynd, Leith. A working model was exhibited in action. This dock is built of boiler-plate iron, with a cavity in the bottom and round the sides capable of being filled with water, which sinks the dock, and the ship is floated into it; the water is then pumped out, when the dock rises, bearing the ship with it, and that part underneath the ship being left perfectly dry, the ship-carpenter can have access to every part of the ship's bottom for all necessary repairs, without having recourse to the dangerous process of "heaving down." The inventor states that a ship is much less liable to be strained in such a floating dock than by being hauled up a long and irregular inclined plane, as the present ships are found in practice to be, when laid down in places where there is little or no rise and fall of tide, and where there is frequently an irregular coral bottom.

2. Description of an Electric Clock on an improved principle. By Mr. John Blackie, electric clockmaker, Meadowbank Station, North British Railway, Edinburgh. The clock was exhibited in action. This clock was stated to be an improvement upon Mr. Bain's electric clock, both in the mode of adjusting the permanent magnets, and in the mode of breaking and re-establishing the circuit; the break being less liable to oxidize. It was also stated that the electric current acted to greater advantage on the coil of the pendulum. Mr. Blackie also claimed as new the simple train of the movement, which consists of very few wheels; and he also claimed a delicate method of adjusting the length of the pendulum. Mr. Blackie was requested to give in, as he promised, a more detailed written description of this clock, accompanied with any necessary drawings.

3. Description of drawing of an Improved Balance or Equilibrium Valve for Locomotives, &c. By Mr. James Squire, mechanic, 17 Reading Street, New Swindon, Wiltshire. The object of this valve is to extinguish the friction usually attendant on the use of the common slide-valve in locomotive engines, and which is the result of the pressure of the steam acting upon the back or exterior surface of these valves. By the proposed construction, the steam is brought to the ports by a method that places the valve in an equilibrium of pressure, on the principle of action and reaction being equal and in opposite directions. The usual friction of the slide is expected to be thereby almost entirely removed.

December 11.

1. Description of Harbour Screw-Cramps, designed for temporary use in binding together the Stones in the construction of Harbour and other Marine Works. By Thomas Stevenson, Esq., F.R.S.E., F.R.S.S.A., Civil Engineer, Edinburgh. A model and drawing were exhibited.

This paper states that the great majority of instances of damage to harbours from gales occurs during construction, or from neglect in repairing, and shows the almost total dependence of a whole pier on the stability of each stone in the structure. Many instances are adduced of harbours suffering great damage during construction, which, after being "closed in" and completed, have withstood the assaults of after-storms. The principle on which these screw-cramps have been designed, is that of coupling stones together in such a manner that the outermost cannot be removed without dragging the adjoining stones along with it. The first of these implements is adapted for a vertical wall, and consists of a cross-rod of iron inserted diagonally between two of the stones of the works, and on either end of this rod chains are slipped—one set being at the front of the wall, and the other at the back. These pass through openings in an abutment-plate placed diagonally across the last stone, and are tightened up by means of capstan-headed screws. The second of these implements is designed more particularly for a talus, or sloping wall, and consists of a kneed abutment-plate (placed upon the last or outermost stone of the unfinished work), connected by chains to a ring-bolt fixed in any stone at a sufficient distance from the open end of the work, or even to a crow-bar driven down between any open joint in the masonry. These chains are tightened up by means of a draw-screw. This apparatus, in the event of a storm coming on suddenly, could be applied in the course of a few minutes.

2. Description of a Fire-Engine on a new principle. By Mr. John White, Engineer, late of Manchester. Communicated by George Wilson, M.D., F.R.S.E., F.R.S.S.A. A model and drawings were exhibited. This fire-engine is patented for England, but not for Scotland. It was stated that it differs in principle from all others hitherto made, and that the following are some of the advantages obtained:—

First, From the number of pumps employed, and their great power, each producing a pressure of 60 lbs. upon the square inch of water, which is as much as twenty men on the average can exert in the common fire-engines by their united power.

Secondly, The men at the common engine may either help or hinder, at their pleasure, without the possibility of detection. This, however, is impossible in this new engine, for as each man has his own pump, he must either do his duty or stand still. Besides, as each pump is a perfect fire-engine of itself, the machine can be worked from one man up to its full complement, while the common engines cannot be worked at all until a sufficient number of hands be put on. That it is evident that the pumps of the common engines must pass their centres at the same moment, which, but for the air-vessel, would render them of little use as fire-engines, and even with its aid, the column of water rises and falls at every stroke of the pumps, as may be seen, occasioning a great waste of power to recover it at every alternate movement of the levers. This evil was stated to be almost entirely overcome by the twelve or more pumps Mr. White employs, one-half of which being in

full power while the others are receiving their water, a uniform pressure is maintained upon the jet, which renders the air-vessel less needful, but with it, nearly as steady as the jet from a fountain.

The third thing Mr. White noticed was his method of preventing the air from mixing with the water, and escaping with a crackling noise as it issues from the jet, breaking the column, and consequently preventing it from reaching the altitude it would otherwise attain. This is accomplished by an improvement in the top of the air-vessel, which has a vulcanized India-rubber cap, supported by a pierced metal shield or diaphragm, through the holes of which the water acts upon the elastic substances, over which is an air-tight dome, and the space between is charged with the compressed air to about 30 lbs. upon the square inch, which is further compressed when the pumps or engine is at work; thus producing a uniform elastic spring that equalizes the flow of the water from the jet, which, leaving no air beyond what is naturally in the water, rises unbroken to a much higher elevation than is reached by the common engine.

Mr. White read certificates from Salford, Manchester, and Glasgow, as to the superiority of his engine to those of the common construction. At Manchester, where a comparative trial was made, Mr. White's engine, with twelve men, sent more water, and to a greater altitude, than the Ganges engine, belonging to the Town Council, worked by twenty-four men; and at Salford, Mr. White's engine, with twelve men, threw the water several feet above the top of a chimney 129 feet high, while the Deluge engine of the old construction, worked by the same number of men, could not throw the water more than half the height; and when the number was afterwards increased to thirty-eight men, they were not able to make the water reach to the top of the chimney.

3. Description of a Cross-cut Sawing Machine, for sawing firewood, &c. By Mr. William Douglas, carpenter to the Right Hon. Lord Torphichen, Calder House, Mid-Calder. A working model was exhibited. This machine consists of a two-handed saw, freely slung in a frame, and moved by a crank at the end of a long bar, having a fly-wheel to turn the centres. Trees, logs, &c., being fixed and adjusted to suit, this simple contrivance cross-cuts them; and it is stated that a man can by its means cut double the quantity he could do by hand, and that the machine can be made complete for £5.

MONTHLY NOTES.

Pastorelli's Dial House Barometer.—Mr. Pastorelli of Cross-street, Hatton Garden, London, has lately introduced some important modifications in the movements of the dial-barometer, whereby improved delicacy and non-liability to get out of order are sought to be obtained. He has also a new arrangement for a self-registering instrument. The index-float on the mercury is attached to a wire or rod on the lower end of a toothed rack, gearing with a pinion on the axis of the index hand, so as to form a rigid connection, in place of employing a silk cord and pulley for this purpose. The cord and pulley action is exceedingly liable to derangement, and is, in addition, very sensitive of hygrometrical changes; therefore, if the rack movement is accurately fitted, its adoption will doubtless remove what is now a great evil. The same movement is used in the self-registering instrument. The index-pinion gears with an additional horizontal rack, carrying at one end a small pin, for the purpose of acting upon two sliding indices, placed one on each side of it, and moving upon a horizontal bar, the points projecting through a graduated slot in the face of the dial. To set it, the indices are brought up into contact with the actuating pin, one on each side, when, of course, the maximum elevation or depression of the mercury is registered by the positions occupied by the indices when the next observation is taken. A small index, furnished with the scale of variation, moveable by the same key which sets the registering indices, notes the height to which the mercury rises, thus obviating the necessity of making a memorandum.

Gair's Brick and Tile Machine.—A brick and tile machine, invented by Mr. Gair of Auchterarder, is stated to be performing wonders in the speed of its production. The working of the clay, and its transmission to the machine, are performed in addition to the mere moulding of the articles. We may shortly be in a position to explain the mechanism which Mr. Gair has introduced—until then, we merely notify the fact of its existence.

Hutchison's Indurated Stone.—A company has lately been formed, under the name of the "Kent and Sussex Indurated and Impervious Stone Company," for the carrying out of an invention of Mr. W. Hutchison of Tunbridge Wells, whereby the softest and most porous stones may be indurated and rendered impervious to wet and frost. The soft Caen stone, and the friable material of the Calverly Quarry in Kent, are both rendered valuable building materials by this process, which is said to be a very cheap one. We shall shortly be able to inspect the indurated stone personally, and shall be able then to report further upon it.

Illustrated Juvenile Literature.—The annals of literature present few more pleasing features than are to be found in the really great improvement in children's books of the present date, as compared with the same class of our early years. Publishers now appear to find it to be their interest to secure the services of writers and artists of standing in their respective professions; and, by their truthful representations, to command that position for their works, which in former times was occupied by unnatural and mere grotesque falsities. With such writers as Mrs. Hall, Mary Howitt, Mr. Goodrich, and others; and such artists as Stanfield, Macbse, Absolon, Leech, and Stone, who have each and all added their quota to the cause, the juveniles of our times may be said to be fairly supplied with useful and amusing literature. As an example, let us take "Peter Parley's Annual for 1849," which is perhaps a fair sample of the best class of this species of literature. The volume before us contains some four hundred pages, admirably printed, and interspersed with chromo-lithographs, tinted steel engravings, and woodcuts, the whole of which, we may say, are equal to the best of their respective styles. The frontispiece, representing the self-devotion of Henry V. at Agincourt, is by Absolon, and is printed in the chromo style by Messrs. Collins and Reynolds. The drawing and colouring of this plate are perfect, as also the title-page of the same kind. Several remarkably fine steel engravings are also given. These are engraved in the mixed style, and printed on a tinted ground. They are perfect specimens of their kind. But the gems of the volume, to our mind, are the woodcuts, scattered most profusely throughout the letterpress. Decidedly the best of the series are those by the Misses Williams. Their productions appear to possess all the many beauties of this method of embellishment, and may be ranked with the best of the day. In the descriptive matter of the volume, which treats on a great variety of subjects, Peter Parley (Mr. Goodrich) has exerted himself with the happiest effect, and the whole fully sustains the well-earned reputation of Messrs. Darton as caterers for the youthful mind.

Mechanics of Agriculture.—Thewlis & Griffith's Churn and Cheese Press.—Churning was anciently practised in the Holy Land by putting the cream into a skin, wherein it was violently shaken. In later times, the churning vessel was a tall and slightly conical barrel, with a covered lid, perforated to admit the rod of an agitating disc, which was rapidly moved up and down by hand. Since then, revolving float-wheels, similar to the paddles of a steamer, have been used for giving a like agitated movement to the cream, placed in a rectangular case; and, lately, we have had the atmospheric churning system, that is, the forcing a strong and diffused current of air through the liquid. Messrs. Thewlis and Griffith, of the Phœnix Pool Works, Warrington, going back upon the principle of the old vertical churn, have improved upon its mechanism, so as materially to expedite the process. In their plan, a conical vertical barrel is employed, having a central vertical shaft, or spindle, which carries at its upper end the bearing for the propelling crank-shaft. The same spindle also serves as a guide for a hollow cylindrical piece, carrying three perforated horizontal dashers, which are worked up and down by a connecting-rod, passing from the sliding cylinder to the crank above. A small fly-wheel is set on the crank-shaft, a little outside the barrel, the shaft being carried on anti-friction rollers. The same firm has just introduced a clever arrangement for a cheese-press. The frame is entirely of iron. The screw-spindle, which works the top pressing-bar, is triple-threaded: it receives motion from the screwed bush of a horizontal bevel-pinion, gearing with a similar pinion set vertically, and carrying an adjustable pressure-lever.

Whitton's Farmer's Portable Mill.—This is a horse-power mill, introduced by Mr. Corbett Whitton of Stafford, for grinding and kibbling all kinds of grain. The stones are set in a horizontal cylindrical cover of galvanized iron, the fitting surface being air-tight. The fixed stone is concave, and the running one convex, on its end-grinding surface, for greater steadiness, and for obtaining a greater extent of grinding surface; this latter point being further improved by curving the faces of the stones in a direction contrary to their motion. The grain is fed from a hopper on the outer end of the fixed stone, a channel conveying it to the centre of the faces. The rotation of the moving stone causes a rarefaction of air in the interior of the containing case, producing, by the equipoising pressure, a constant current of air in the direction of the feed, which is thus proportioned to the speed of working, and the acting surfaces are kept cool. The whole mechanism is set on two cast-iron standards, the spindle carrying a driving-pulley for communicating with a horse-power apparatus.

Wornell's "Stricken Deer."—Mr. John Wornell, modeller, of this city, has lately completed a work of great merit, which deserves remark. The subject is the "Stricken Deer." The ground is rugged and uneven, and the deer is just falling against the prostrate trunk of a tree. The bent fore-leg of the animal, resting on the tree, expresses how its last faltering steps have been cut short; whilst the position of the hind ones, against which no obstacle has presented itself, are still essaying to give it a flying movement. The size of the cast is about 8 inches by 6. It is in a composition of wax, which appears peculiarly well fitted for such purposes, as it gradually attains great hardness, and preserves a good tone of colour, as the specimen we have by us practically proves.

The "Brigand" and "Pirate" Screw Steam-Ships.—The "Brigand" and "Pirate" are two iron screw-steamers, lately built and engine-fitted by Messrs. Smith and Rodger of this city. As they embody some original details, we have thrown together a few notes for reference. The engines are on Mr. David Napier's four-piston-rod direct-action principle: cylinders 30 inches diameter, and the same stroke; strokes per minute, 27; collective power, 60 horses. Cog spur-wheel, on crank-shaft, of 47 teeth, 4 inches pitch, and 18 inches broad; gearing with a pinion on screw-shaft of 19 teeth. The wheel-arms are in the improved fashion of double-feathers—are on each side, in place of a single central one. Screw-propeller is of wrought-iron, 9 feet diameter, with two blades 14 feet pitch. The boiler is tubular, having 176 2¾-inch tubes 6 feet in length. The boiler itself is 8 feet 8 inches, by 9 feet 4 inches. Three furnaces, each 2 feet wide; bars, 5 feet in length. Length of ship's keel, 135 feet; breadth of beam, 23 feet 6 inches. Depth of hold, 13 feet 6 inches. The mean rate of sailing is 9 knots per hour; the screw making 2½ revolutions for 1 of the engine-shaft.

Art-Manufactures Circular.—In pursuance of his scheme for wedding high art to manufactures, Felix Summerley has commenced the issue of a miniature periodical, as an illustrated catalogue of his productions. We know not how often the parts are to appear, as the only numbers yet issued, I. and II., bear date, respectively, March and December, 1848. They are not exclusively devoted to the cataloguing of the art-manufactures, but contain here and there a stray note of the passing events of the world of art. The typography is of the old-fashioned text, with ornamental initial letters. The illustrations, considered simply as wood-

engravings, are in themselves admirable examples of the art. Of the designs which seem more particularly to deserve mention, are two statuettes of children, "Prayer and Belief," by John Bell. The head and attitude of the one representing "Prayer," are remarkably expressive and well-conceived. The "Twins," being a pair of brackets in terra cotta by the same modeller, are also very beautiful. A tea-caddy spoon, with tea-plant handle, by H. G. Rogers, as also a set of three decanter-stoppers, representing figures gathering the grapes, treading out the juice, and examining the made wine, by J. C. Horsley, are good. Redgrave has developed his ideas in the "Well-spring" water-vase. It is of glass, with double handles: a floral ring adorns the lower part of the neck; and the body is ornamented with water plants springing from the base, coloured and enamelled on the glass. Townsend has an "Infant Neptune," manufactured in Parian and silver. It is a vigorous composition. We hope to see yet further improvement in this class of art, hitherto so utterly neglected.

How the Mechanical Virtue of Fuel is Estimated and Expressed.—1. In explaining the mechanical effects of steam, it has been already shown that whatever be the purpose to which the force of a steam-engine be applied, its effect may always be represented by a certain weight raised a certain height. 2. Whether an engine be employed to drive a mill-wheel, to propel a ship, or to draw a carriage, the tension or resistance to be encountered at the working point may be universally represented by an equivalent weight. 3. Thus it is easily understood, if a locomotive engine draws a train of carriages, that the tension of the chain which connects the engine with the train will be the same as if the same chain, in a vertical position, had a certain weight suspended to it; and the same will be true, whatever be the nature of the resistance to the moving power, or the manner in which this moving power may be applied. 4. It has been usual also to express the mechanical efficacy by the number of pounds raised one foot; for whatever be the resistance, and whatever be the space through which the moving power acts upon it, the effect can always be reduced, as has been already explained, to an equivalent number of pounds raised one foot. 5. The mechanical virtue of coals, thus explained and applied to a steam-engine, has been technically called the *duty of the fuel*. Thus, a bushel of coals consumed in the furnace of an engine will enable such engine to exert at the working point a mechanical effect equivalent to a certain number of pounds raised one foot high; this effect is the duty of the fuel, or as is sometimes said, the duty of the engine. 6. The duty of the engine is therefore not the entire mechanical effect developed by the fuel in producing evaporation; for a portion of the mechanical power of the steam evolved in the boiler, and in some cases a very large portion of it, is expended in moving the machinery of the engine itself; all such portion is intercepted, therefore, between the furnace and the working point. The duty, properly speaking, is the net mechanical force developed by the steam, or such portion only which is available for the work to which the engine is applied. 7. The duty of engines varies within very wide limits, according to the purpose to which they are applied. In this respect, engines may be reduced to three classes:—1st, Such as are used in the mining districts of Cornwall, where the economy of fuel is pushed to its extreme limit; 2ndly, The stationary engines used in the manufactories generally, in which class may also be included marine engines; 3rdly, Locomotive engines on railways. 8. In the Cornish engines, where alone very accurate observations are made on the mechanical effect produced, and on the economy of fuel, it has been found, in some cases, that by the combustion of a bushel of coals an effect has been produced by the engine equivalent to 125 millions of pounds, or what is the same, 62,000 tons raised a foot high. This, however, is not to be understood as an average result. In producing it, the utmost care was taken to guard against every source of waste of power. 9. The more common duty obtained from a well-managed engine used in the mining districts has been from 80 to 90 millions of pounds, or at the rate of one million of pounds raised one foot for every pound of coal consumed,—a result remarkable enough in itself, and easily remembered. 10. In the ordinary stationary engines belonging to the second class, where the same scrupulous attention to economy cannot be or is not paid, the duty, according to the commonly received estimate, is, in round numbers, about 20 millions of pounds for a bushel of coal, being four times less than that of the good Cornish engines, and six times less than the duty which has in certain cases been obtained. 11. In the locomotive engines worked on railways, the economy of fuel is of course still less; but in this application of the engine the economy of fuel becomes a consideration so subordinate, that it need not be enlarged on here. 12. The great economy obtained in the engines used in Cornwall is the result of a variety of contrivances, some of which, such as the protection of the machinery from radiation, have been already mentioned. The boilers are constructed of extraordinary magnitude, in proportion to the power expected from them; the furnace is of proportionate size; the combustion is slow; the heating surface is very extensive, and the intensity of heat upon it very slight; the flues are of great length, and the heated air is not permitted to escape until the last available portion of heat has been extracted from it; the fuel is managed in the furnaces with the most extreme care, the combustion being perfect. Added to all this, the steam is used at a pressure of from 35 to 50 lbs. per square inch above the pressure of the atmosphere, and the expansive principle extensively applied. 13. In giving these last estimates of the duty of fuel in the engines used in the manufactures generally, it is right to observe, that owing partly to the difficulty of ascertaining the actual mechanical effect produced, and partly to the negligence of proprietors of engines, the estimates of duty are of the most loose and inaccurate description. When an engine is applied, as is generally the case in Cornwall, directly to the elevation of water or other heavy matter, it is easy to observe the mechanical effect it produces; but when an engine is applied to give motion to the works of a factory, to drive spinning-frames, power-looms, or printing-presses, it is not so easy a matter to reduce the effect it produces to an equivalent weight raised a given height. In the case of locomotive engines the same difficulty ought not to exist; yet it is surprising that, until a very recent period, errors the most monstrous prevailed respecting the real mechanical effect produced by these machines. It was, for example, long assumed as a maxim, that the resistance offered by a given train of carriages to a locomotive engine was independent of the speed, or in other words, the same at all speeds. This error was not brought to light until the year 1838, when it was demonstrated, by a series of experiments conducted by me, that the resistance was augmented in a very high ratio with the speed.—*Dr. Lardner's Rudimentary Treatise on the Steam-Engine.*

Present Condition of Lithography.—Messrs. Maclure and Macdonald, the eminent lithographers, have just issued a presentation plate to their friends, as an example illustrative of the existing state of the lithographic art. Mr. Scott Lauder's picture "Morning" has been chosen for the subject of their performance, and they who are acquainted with the original, will agree with us in according praise to the artist of the stone, for his faithful reproduction of Mr. Lauder's beauties. A female figure, seated in a sea-shell, forms the prominent feature of the plate. She is drawn gently along the liquid surface of the ocean, by two swans harnessed by floral reins held by the figure. The far-off dim opening in the sky, giving token of the coming dawn—the attitude of the figure—and the placid ripple of the waters, are each admirably given, and exemplify the capabilities of the lithographic chalk, when handled by a true artist.

ENGLISH PATENTS.

Sealed from 15th December, 1848, to 18th January, 1849.

Joseph Eccles, Moorgate Fold Mill, near Blackburn, Lancaster, cotton-spinner, and James Bradshaw, and William Bradshaw, of the same place, watchmakers,—"Certain improvements in, and applicable to looms, for weaving various descriptions of plain and ornamental textile fabrics."—December 15th.

William Wharton, superintendent of the carriage department of the London and North Western Railway Station, Euston-square,—"Certain improvements in the construction of vehicles used on railways, or on other roads and ways."—15th.

Henry Walker, Gresham-street, London, needle manufacturer,—"Certain improvements in the process or processes of manufacturing needles."—16th.

William Wild, Salford, Lancaster, moulder,—"Certain improvements in rotary steam-engines."—16th.

Alfred Vincent Newton, Chancery-lane,—"Improvements in casting printing types and other similar raised surfaces, and also in casting quadrats and spaces."—(Communication.)—16th.

William Clay, Clifton Lodge, Cumberland, engineer,—"Certain improvements in machinery for rolling iron or other metals, parts of which improvements are applicable to other machinery in which cylinders or rollers are used."—16th.

Joseph Deeley, Newport, Monmouth, engineer,—"Improvements in ovens and furnaces."—16th.

Edward Smith, Kentish Town, London, window-blind manufacturer,—"Improvements in window-blinds, and in springs applicable to window-blinds, doors, and other like purposes."—16th.

William Major, Culcheth, near Leigh, Lancaster, manufacturer,—"Improvements in looms for weaving certain descriptions of cloths."—16th.

John Cartwright, Sheffield, York, tool-maker,—"An improved brace for the use of carpenters and others."—16th.

John Clinton, Greek-street, Soho-square, professor of music,—"Improvements in flutes."—16th.

John Travis and John M'Innes, Liverpool, lard refiners,—"Improvements in packing lard."—16th.

William Curtain, Retreat-place, Homerton, gentleman,—"Certain improvements in the method of manufacturing Brussels tapestry, Turkey, and velvet, or cut pile carpets and velvets, silks, linen, mixed cloths, and rugs of all descriptions, by which method less warp is required, and perfect and regular figures or patterns are produced."—16th.

Thomas Dickens, Middleton, Lancaster, silk manufacturer,—"Certain improvements in machinery or apparatus for warping and beaming yarns or threads composed of silk or other fibrous materials."—21st.

William Wilkinson, Dudley, Worcester, manufacturer,—"A certain improvement or certain improvements in the construction and manufacture of vices."—21st.

James Henry Staple Wildsmith, City-road, London, experimental chemist,—"Improvements in the purification of naphtha (called wood spirit, and hydrated oxide of Methyte), pyroligneous acid, and eupion, and certain other products of the destructive distillation of wood, peat, and certain other vegetable matters, and of acetate of lime and shale, and in the purification of coal tar and mineral naphtha, likewise spirit being the products of fermentation."—21st.

Charles Augustus Hohn, King William-street, civil engineer,—"Improvements in printing."—21st.

John Penn, Greenwich, Kent, engineer,—"Certain improvements in steam-engines."—21st.

Pierre Armand Le Comte de Fontainemoreau, South-street, Finsbury, London,—"Certain hygienic apparatus and processes for preventing and curing chronical and other affections, and to prevent or stop certain epidemic diseases."—(Communication.)—21st.

William Baker, Edgbaston, near Birmingham, civil engineer, and John Ramsbottom, Longsight, near Manchester, engineer,—"Improvements in the construction of railway wheels, and in railway turn-tables, which latter improvements are applicable to certain shafts or axles driven by steam or other motive power."—21st.

William Riddle, White Friar-street, London, gentleman,—"Improvements in the construction of ever-pointed pencils, writing and drawing instruments, and in inkstands or inkholders."—21st.

Charles Low, Roseberry-place, Dalston, gentleman,—"Improvements in smelting copper ore."—28th.

George Ferguson Wilson, Belmont, Vauxhall, gentleman, and Charles Humphrey, Manor-street, Old Kent-road, merchant,—"Improvements in the production of light, by burning oleic acid in lamps, and in the construction of lamps and manufacture or preparation of oleic acid for that purpose."—28th.

William Dingle Chowne, Connaught-place West, M.D.,—"Improvements in ventilating rooms and apartments."—28th.

Moses Poole, London, gentleman,—"Improvements in the manufacture of heels for boots and shoes, of swivels, of bag fastenings, of revolving furniture, and of the connection of pipes for gas and other fluids."—(Communication.)—28th.

John Mitchell, chemist, Henry Alderson, civil engineer, and Thomas Warriner, farmer, Lyons Wharf, Upper Fore-street, Lambeth,—"Improvements in smelting copper."—28th.

Israel Kinsman, late of New York, but now of Ludgate-hill, merchant,—"Improvements in the construction of rotary engines to be worked by steam, air, or other elastic fluid."—28th.

William Edward Newton, Chancery-lane, civil engineer,—"Certain improvements in steam-engines."—(Communication.)—28th.

Robert Jobson, Holly Hall Works, near Dudley, Stafford, engineer,—"Improvements in the manufacture of stoves."—28th.

William Gilmour Wilson, Port-Dundas, Glasgow, engineer,—"Improvements in the formation of moulds, and cores of moulds, for casting iron and other substances."—20th.

William Knapton, York, ironfounder,—"Certain improvements in the mode of manufacturing gasometers or gasholders."—January 3d.

William Thomas, Cheapside, London, merchant,—"Improvements in the manufacture of window-blinds."—(Communication.)—4th.

David Yoolow Stewart, Montrose, Scotland, ironfounder,—"Improvements in the manufacture of moulds and cores for casting iron and other substances."—4th.

Henry Francis, Chelsea, Middlesex, engineer,—"Improvements in sawing and cutting wood."—4th.

Robert Munn, Stack Head Mill, near Rochdale, Lancaster, cotton-spinner,—"Certain improvements in looms, and apparatus connected with looms, for weaving various descriptions of textile fabrics."—4th.

William Crofton Moat, Upper Berkeley-street, Middlesex, surgeon,—"Improvements in engines to be worked by steam, air, or gas."—4th.

John Coope Haddan, 29, Bloomsbury-square, civil engineer,—"An improvement or improvements in railway wheels."—5th.

Francis Hobler, Bucklersbury, London, gentleman,—"Improvements in the construction of the cylinders or barrels of capstans and windlasses."—11th.

Michael Loam, Treskerley, Cornwall, engineer,—"Improvements in the manufacture of fuzees."—11th.

Christopher Nickels, Albany-road, Surrey, gentleman,—"Improvements in preparing and manufacturing India-rubber (caoutchouc)."—11th.

William Rowe, New Wharf, Whitefriars, London, carpenter and joiner,—"Certain improvements in the mode of uniting or combining pipes, or lengths of pipes, tubes, or channels formed of glass, earthenware, or other similar material."—11th.

William Walker, Manchester, agent,—"Certain improvements in machinery or apparatus for cleaning roads or ways, which improvements are also applicable to other similar purposes."—11th.

Miles Wrigley, Ashton-under-Lyne, architect,—"Certain improvements in the manufacture of yeast or barm."—11th.

William Edward Newton, Chancery-lane, civil engineer,—"Certain improvement or improvements in the construction of wheels."—(Communication.)—11th.

James Castley, Harpenden, Hertford, manufacturing chemist,—"Improvements in the manufacture of varnishes from resinous substances."—11th.

Robert Urwin, Ashford, Kent, engineer,—"Certain improvements in steam-engines, which may, in whole or in part, be applicable to pumps and other machines not worked by steam power."—11th.

Obed Blake, Thames Plate Glass Company, residing at 13 Sontbampton-street, Strand, gentleman,—"Certain improvements in ventilating or ventilators for or in ships, vehicles, houses, or other buildings."—11th.

Richard Laming, Clichy la Garonne, near Paris, France, chemist,—"Improvements in the modes of obtaining or manufacturing sulphur and sulphuric acid."—July 13th. N.B.—This patent being opposed by caveat lodged at the Great Seal Patent Office, was not sealed till the 13th January, 1849, but bears date the 4th September, 1848, the day it would have been sealed and dated had no opposition been entered (by order of the Lord Chancellor).

William Betts, Smithfield-bars, London, distiller,—"A new manufacture of capsules, and of a material to be employed therein, and for other purposes."—13th.

George Williams, Tipton, Stafford, forge manager,—"A certain improvement or improvements in preparing puddling furnaces used in the manufacture of iron."—13th.

Conrad Haverkam Greenhow, London, civil engineer,—"Certain improvements in atmospheric railways."—13th.

Richard Dugdale, Brompton, Middlesex, engineer,—"Improvements in hardening articles composed of iron."—13th.

Anthony Barberis, Leicester-square, engineer,—"Improvements in spinning silk, and in the construction of swifts, and in the arrangement of apparatus for winding silk and other fibrous substances."—16th.

Jean Baptiste Francois Mazeline Cline, Havre, France, engineer,—"Improvements in steam-engines, and in the machinery for propelling vessels."—16th.

William Martin, St. Pierre les Calais, France, mechanist,—"Certain improvements in machinery for figuring textile fabrics, parts of which improvements are applicable to playing certain musical instruments, and also to printing, and other like purposes."—16th.

Peter Augustine Godefroy, London, chemical colour manufacturer,—"Certain improvements in dressing and finishing woven fabrics."—16th.

Edward Buchler, London, merchant,—"Improvements in the manufacture of boots and and shoes, also applicable to other fabrics."—16th.

Carey M'Clelland, Larch Mount, in the liberties of the city of Londonderry,—"An improved corn-mill."—16th.

James Hamilton, London, civil engineer,—"Improvements in cutting wood."—18th.

John Francis Bottom, Nottingham Park, Nottingham, lace dresser, and John Dearman Dunnicliff, Hyson Green, Nottingham, lace manufacturer,—"Improvements in dressing or getting up fabrics of cotton or silk, and of cotton and silk combined."—18th.

Francis Alton Calvert, Manchester, mechanist,—"Certain improvements in machinery for cleaning and preparing cotton wool and other fibrous substances."—18th.

Thomas Newcomb, Bermondsey, machinist,—"Improvements in furnaces."—18th.

SCOTCH PATENTS.

Sealed from 26th December, 1848, to 19th January, 1849.

Stephen Taylor, Ludgate-hill, London, gentleman,—"Certain improvements in the construction of fire-arms, and in cartridges for charging the same."—December 26th.

George Fergusson Wilson, Belmont, Vauxhall, Surrey, gentleman, and Charles Humphrey, Manor-street, Old Kent-road, Surrey, merchant,—"Improvements in the production of light by burning oleic acid in lamps, and in the construction of lamps, and manufacture or preparation of oleic acid for that purpose."—28th.

Robert Angus Smith, Manchester,—"Improvements in the application and preparation of coal tar."—January 4th.

William Gilmour Wilson, Port-Dundas, Glasgow, engineer,—"Improvements in the formation of moulds, and cores of moulds, for casting iron and other substances."—4th.

Edward Schnuck, Rochdale, Lancaster, chemist,—"Improvements in the manufacture of malleable iron, and in treating other products obtained in the process."—8th.

David Yoolow Stewart, Montrose, Scotland, ironfounder,—"Improvements in the manufacture of moulds and cores, for casting iron and other substances."—10th.

John Mitchell, chemist, Henry Alderson, civil engineer, and Thomas Warriner, farmer, Lyons Wharf, Upper Fore-street, Lambeth, Surrey,—"Improvements in smelting copper."—10th.

John Wright, Camberwell, Surrey, engineer,—"Improvements in generating steam and evaporating fluids."—10th.

Richard Roberts, Globe Works, Manchester, Lancashire, engineer,—"Certain improvements in and applicable to clocks and other time-keepers, in machinery or apparatus for winding clocks and hoisting weights, and for effecting telegraphic communication between distant clocks and places, otherwise than by electro-magnetism."—11th.

Edward Slaughter, Avonside Iron Works, Bristol, engineer,—"Improvements in marine steam-engines."—12th.

Israel Kinsman, late of New York, now of Ludgate-hill, London, merchant,—"Improvements in the construction of rotary engines, to be worked by steam, air, or other elastic fluid."—(Communication.)—12th.

Edward Smith, Kentish Town, Middlesex, blind manufacturer,—"Improvements in window-blinds, and in springs applicable to window-blinds, doors, and other like purposes."—16th.

Andrew Lamb, Southampton, Hants, engineer, and William Alltoft Summers, Millbrook, Southampton, engineer,—"Certain improvements in steam-engines and steam-boilers, and in certain apparatus connected therewith."—16th.

William Edward Newton, of the Office for Patents, 66, Chancery-lane, Middlesex, civil engineer,—"Improvements in the construction of stoves, grates, furnaces, or fire-places, for various useful purposes."—(Communication.)—17th.

Andrew Shanks, Robert-street, Adelphi, Middlesex, engineer,—"An improved mode of giving form to certain metals when in a fluid or molten state."—17th.

James Hamilton, London, civil engineer,—"Improvements in cutting wood."—17th.

James Young, Manchester, Lancashire, manufacturing chemist,—"Improvements in the preparation of certain materials, and in dyeing and printing."—19th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 15th Dec. 1848, to 18th Jan. 1849.

Dec. 15th,	No. 1701.	M'Lardy & Lewis, Salford,—"Flyer top for preparing spinning cotton, and other fibrous substances.
—	1702.	Robert Sargison, Wisbeach,—"Straw-shaking machine, for separating the corn from pulse."
16th,	1703.	Timothy Adams Jordan, Old-street Road, London,—"Tyre."
—	1704.	Stephen Barton, Bristol,—"An open or close carriage with a round cornered glass front."
—	1705.	Myer Myers, Birmingham,—"Penholder."
18th,	1706.	A. Grant Brothers, Clements-court, Cheapside,—"The Beaufort collar."
—	1707.	Joseph Fenn, Newgate-street,—"Double-headed cylinder wrench."
19th,	1708.	Wm. Hen. Neuber, Long-acre,—"Placard-holder."
—	1709.	Thomas Davy Durant, Lindfield, Sussex,—"Sound-board receiver for piano-fortes."
20th,	1710.	Jos. Sam. Hodge, New Oxford-street,—"Safety-pocket or receptacle."
—	1711.	John Hitchen, Tarporley, Chester,—"Vent-peg."
23d,	1712.	Thomas Davis, Warwick,—"Threshing machine."
26th,	1713.	Thewlis & Griffith, Warrington,—"Churn."
29th,	1714.	George Forester & Co., Liverpool,—"Hydrant, or slide-valve, for water-pipes, fire-hose, and other purposes."
—	1715.	Towns & Packer, Oxford-street,—"Improvements in the action of piano-fortes."
—	1716.	John Bryce, Glasgow,—"Hydrostatic pressure regulator."
30th,	1717.	Julius Singer, Princes-street, Leicester-square,—"Portable wrapper vest."
Jan. 1st,	1718.	Isaac Moses (trading under the firm of E. Moses & Son), Minories,—"Duplex waistcoat."
—	1719.	Charles Carr Williams, Railway Carriage Wor[illegible], Goswell-street,—"Balance frame for door glasses, or shutters, for railway and common road carriages."
3d,	1720.	John Greenwood, jun., Mold Green, Huddersfield,—"Rack and pinion shuttle."
5th,	1721.	Stock & Son, Birmingham,—"Economic water-closet."
6th,	1722.	Dixon, Sons, & Tooke, Hatton Garden,—"Safety clasp."
—	1723.	Stock & Son, Birmingham,—"Economic self-acting water-closet."
8th,	1724.	Joseph Human, Ely,—"Rain-protector."
9th,	1725.	Buller & Co., Walsall,—"Bit for horses."
10th,	1726.	Geo. Henry Baskcomb, Chiselhurst, Kent,—"Triune dog-cart."
—	1727.	Thomas Cartwright, Birmingham,—"Ladies' improver, or bu[illegible]"
11th,	1728.	Simcox, Pemberton, & Sons, Birmingham,—"Blind furniture."
12th,	1729.	Isaac Moses (trading under the firm of E. Moses & Son), Minc London,—"The Sternophylon, or shirt and chest protector."
—	1730.	Charles Otto Wilckens and Richard Hesse, James-street, St. Luke,—"Compound wrench."
13th,	1731.	John Young, Wolverhampton,—"Lock."
—	1732.	George Dudley Ryder, Grace Dieu Warren, Leicester,—"Double bow suspension spring for carriages."
—	1733.	Charles Rickets, Agar-street, Strand,—"Economic gas-cooking stove."
17th,	1734.	Josiah Evans, Warrington,—"Steam-valve."
—	1735.	Thomas Nash, jun., Southwark,—"Painter's brush."
18th,	1736.	Charles Otto Wilckens and Richard Hesse, James-street, St. Luke's,—"Marginal seal stamp."

TO READERS AND CORRESPONDENTS.

The next Part completes the First Volume of this Journal.—Subscribers may obtain CLOTH COVERS for their Numbers, at the Office, 33 Buchanan Street, Glasgow; from Mr. Hebert, 88 Cheapside, London, or from any Bookseller.

BOOKS RECEIVED.—"Wilme's Manual of Writing and Printing Characters;" "Transactions of the Royal Scottish Society of Arts," Volume III. Parts II. and III.; "A Letter to Viscount Ebrington, M.P.," by N. Beardmore, C.E.; "Tredgold on the Steam-Engine," new edition, Parts IV. and V.

Y. G. M.—We have referred his query to the writer of the article, who is abroad.

MR. MENNIE, Forfar.—His model has been received, but too late for any notice this month. We will attend to his request.

J. P.—We have his communication. We cannot always reply in the way he wishes.

MR. BUCKLE'S BONE MILL.—A correspondent writes to us, what is the best position for the stampers used in this mill; the best method or apparatus for lifting them; the most suitable method of guiding the bars to which the stampers are fixed; what is meant by the shape of the stampers being like an inverted cross; and the best bed for working them upon? Also, whether the bed-plate of the stampers should be level or inclined, for the bones to pass from one to another, and whether or not the bed should be wider than the stamper faces?

W. TORTOISE.—If he will forward us a drawing of his cutting slide, we will attend to it. We have never seen it. When we see what it is, the remainder of his remarks will be attended to.

R. E. M., Cheltenham.—His articles will be duly acknowledged when they arrive.

Messrs. SPILLER and TAYLER'S communication came to hand too late for use this month.

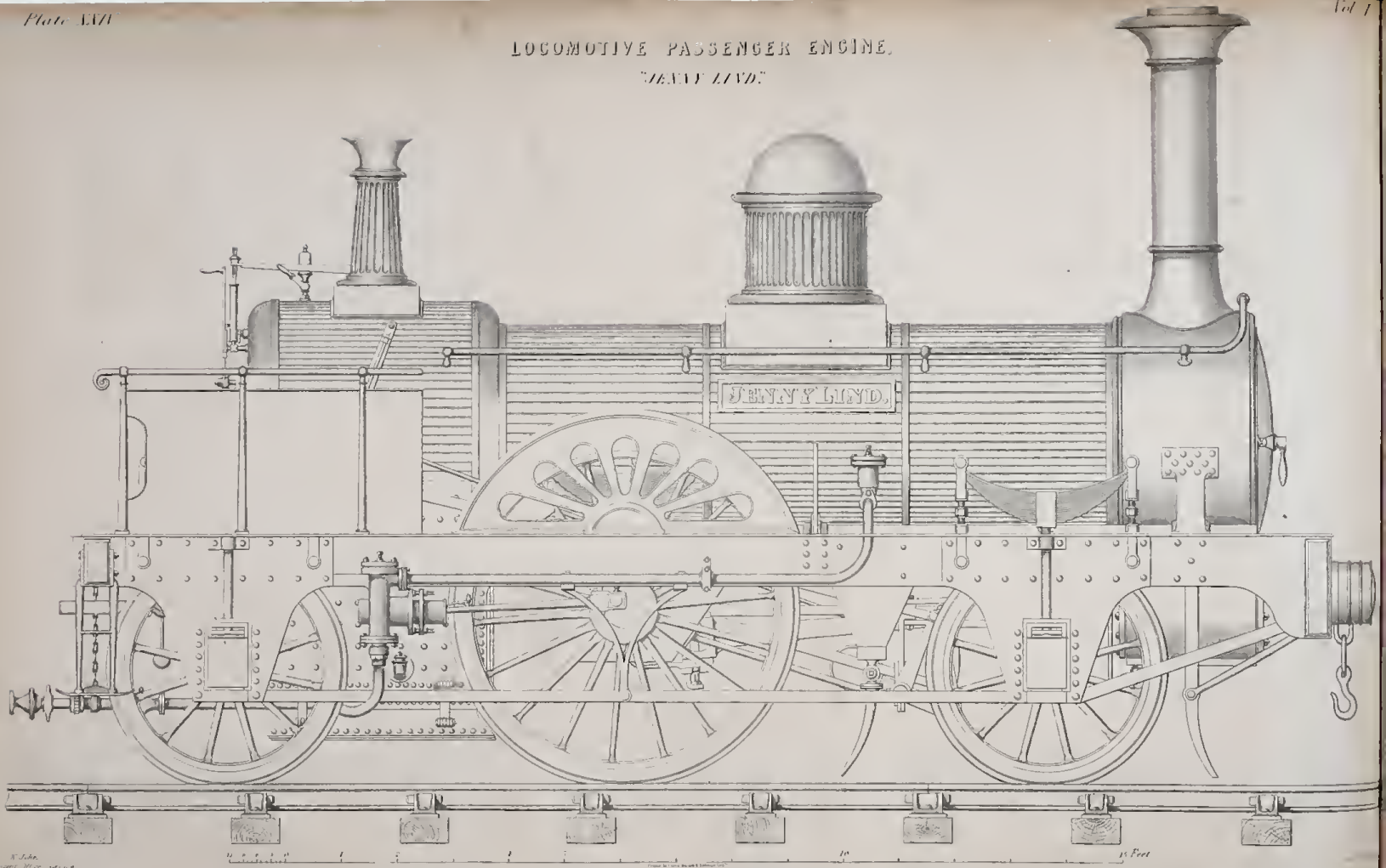
T. G. W., Dundee.—We do not think there is a work on dyeing linen yarns in existence. White's book on Weaving by Hand and Power, is a good work,—published by Niven, Glasgow.

J. WALTERS.—His request had escaped us. We will look over the matter.

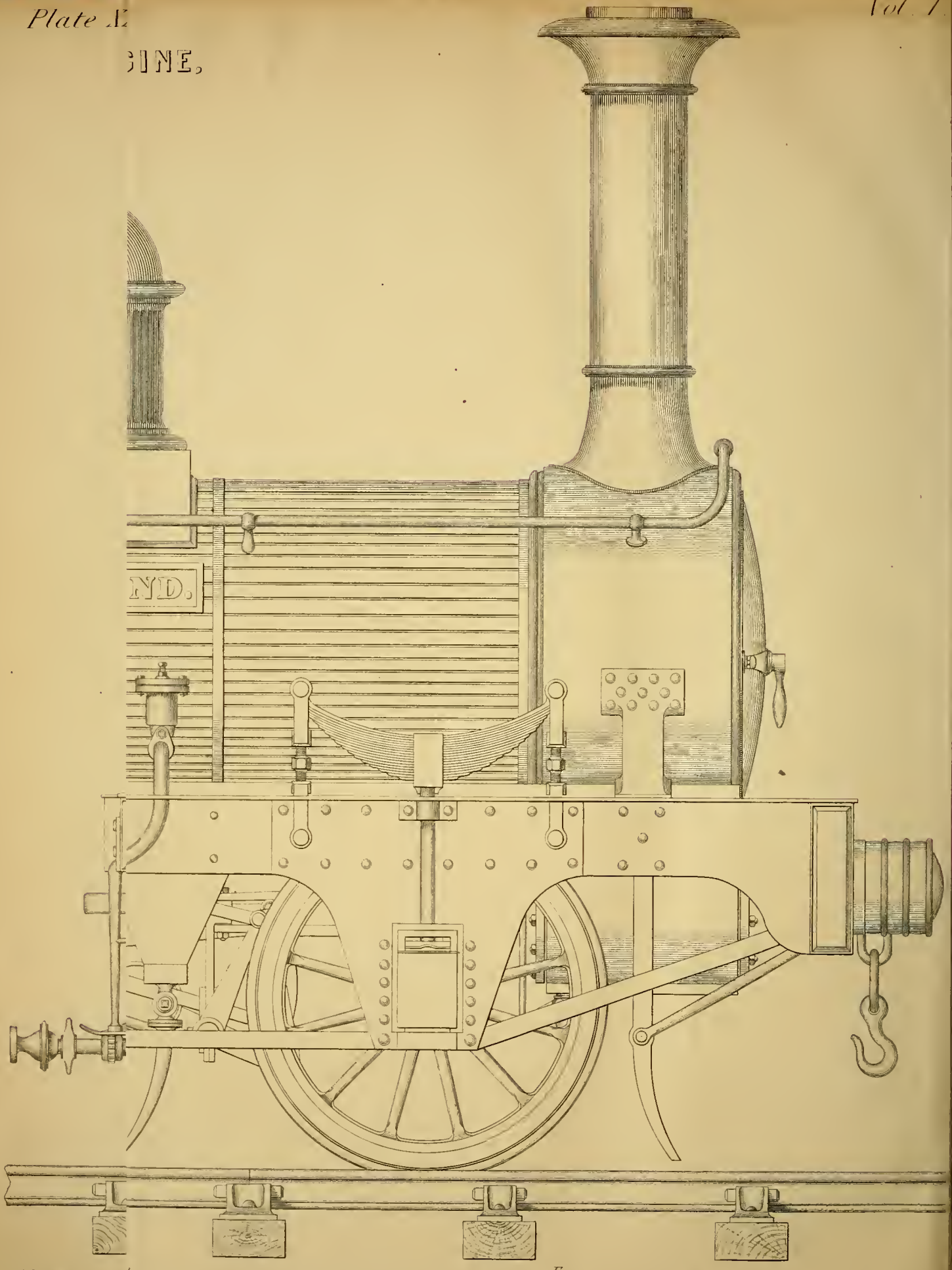
J. BROOK asks, "In trundling a hoop, where does the blow of the stick produce the best effect?"

LOCOMOTIVE PASSENGER ENGINE.

"JENNY LIND."



;INE,

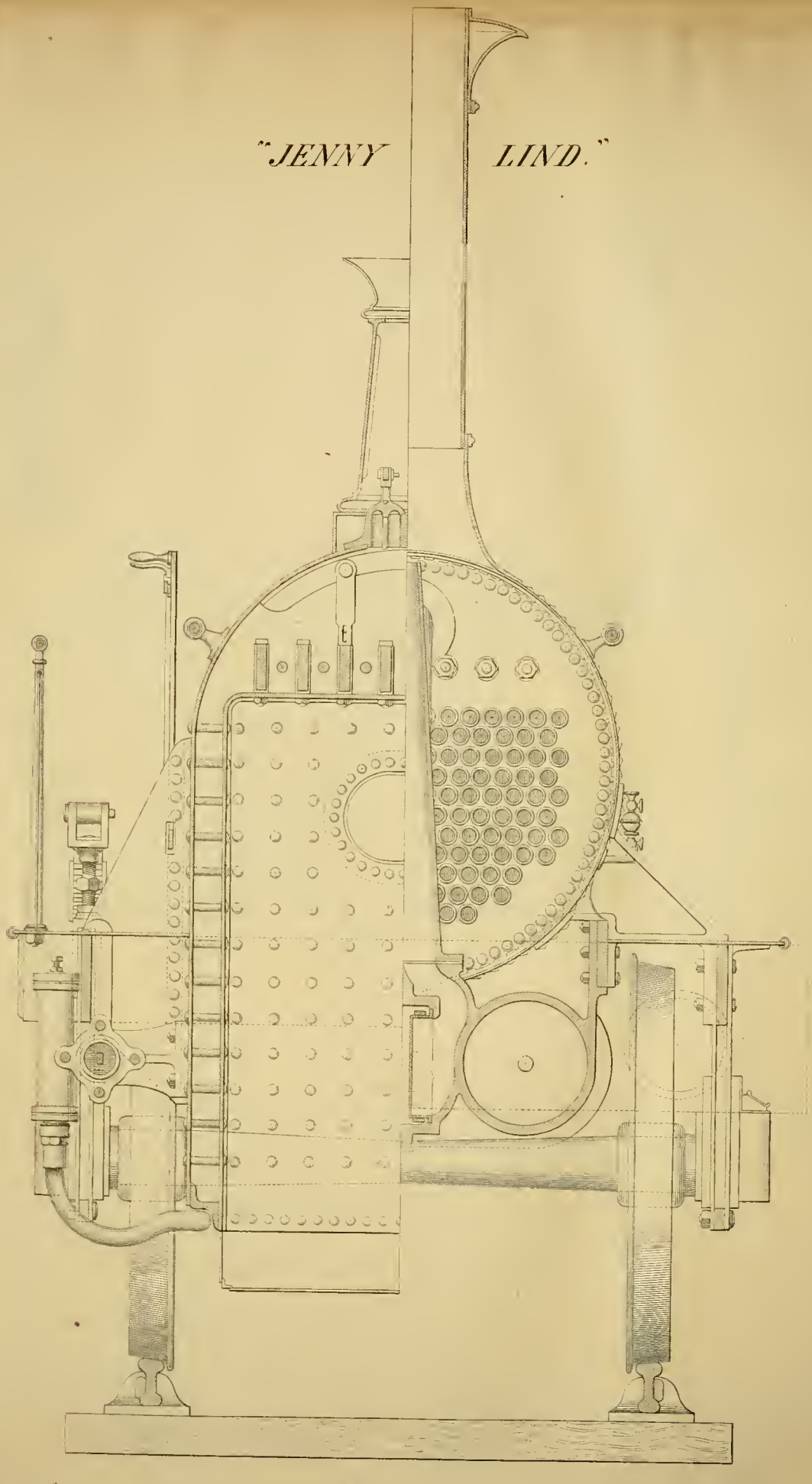


15 Feet

W. Johnson, Patent Office, Glasgow.

Geo. Bakewell, L

"JENNY LIND."

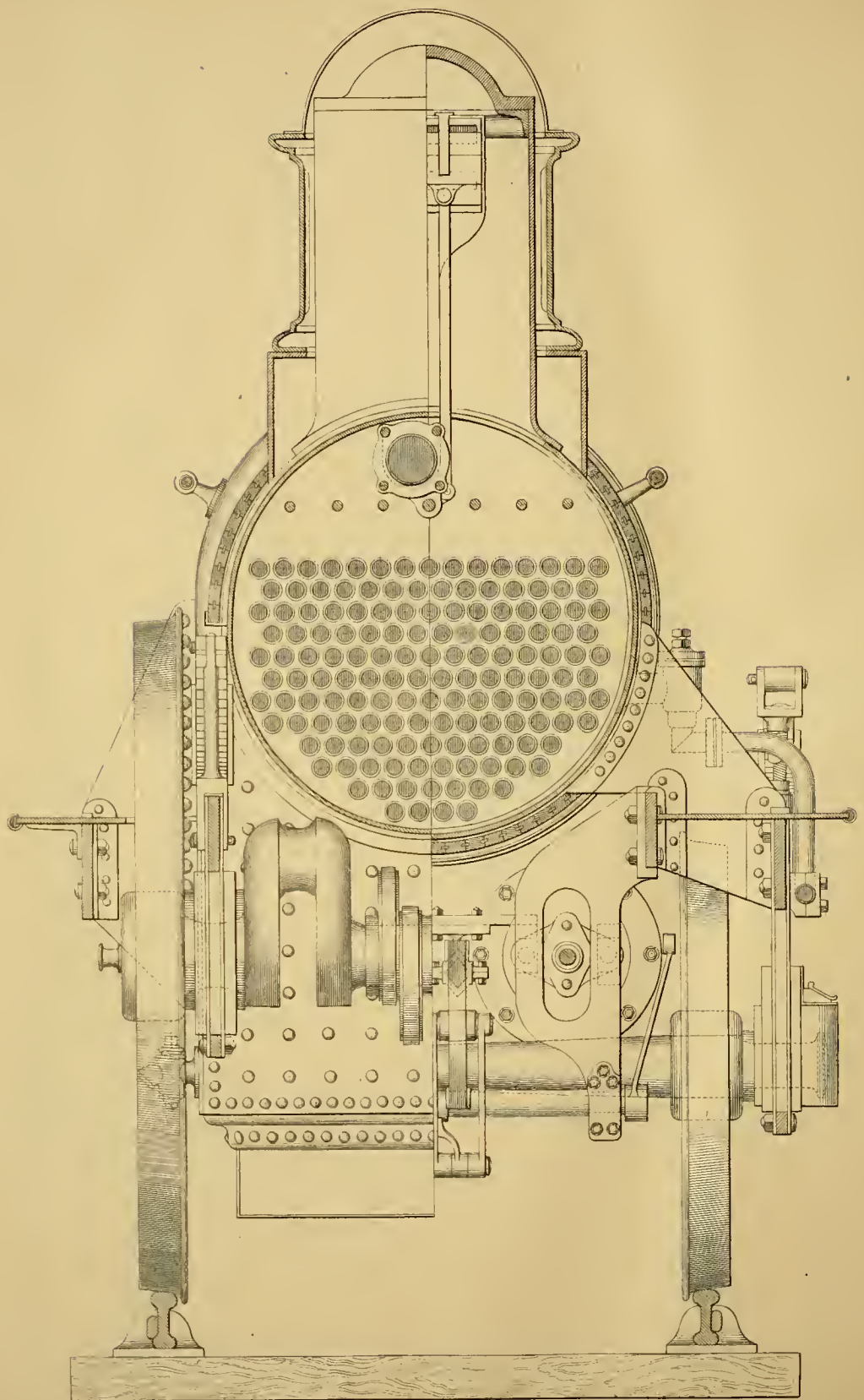


12 6 0 1 2 3 4 5 10 F.

Printed by Cars Mackay & Hartswood, Edin.

W. Watson
Patent Office, Glasgow.

G. A. Rons



12 6 0 1 2 3 4 5 10 Ft

W. Johnson
Patent Office Glasgow.

Printed by Maclure & Macdonald, Lith.rs Glasgow, Liverpool & London

G. Aikman

BIRMINGHAM AND ITS MANUFACTURES.

Metal-working Birmingham, whether regarded in reference to its chronicles of the past, or its existing condition, is to be noted as one of the most extraordinary results of human industry. Unassisted by any local advantages, by government patronage, or any of the numerous monopolies which are generally found combining to build up a city's greatness, ancient *Bromwycham* has elbowed its way forward from the time of Charles II., when one street marked its position, and 5,000 numbered its population, to its present mazy ramifications of buildings, covering 200,000 inhabitants, whose industrial exertions have made them known in every nook and cranny of the world. The place was of some importance in the time of the Romans, and the ancient way of Icknield Street passes through its suburbs. But it was not until the time of the second Charles, that its commercial progress became at all remarkable. Since this date, metal manufactures have nowhere flourished so well as under the management of its energetic sons, for throughout Great Britain there is hardly a house to be found where articles of its production are wanting. The pen wherewith we trace these notes, the inkstand in which we dip it, and the chandelier which gives us light, all had their origin in Birmingham; and of the thousand trifling articles of convenience surrounding us, the same remark may be made.

Cutting tools and nails appear to have been among the first articles of manufacture here; and that the former class of products were not always intended for peaceful pursuits, is shown by the fact of the supply of 15,000 sword-blades to the Parliamentary troops in their strife with the royalists of Charles I. Camden's 'Britannia,' dated 1772, informs us that at that time "most of the inhabitants be smithes and other artificers in steel and iron, whose performances in that way are greatly prized." Brass was introduced as a material of manufacture, some twenty years later, by John Taylor, an eminent man in his day, who improved, if he did not invent, the stamp and press. Japanning was first put in operation there by the celebrated Baskerville, whose house, now used as a manufactory, still bears his name. The Soho Works of Boulton & Watt were commenced in 1764; and hence may be dated the rapid rise of the place. The present leading branches of manufacture are jewellery, buttons, plate, arms, toys, hardware, metals of all kinds, and tools. Many things, of which the world at large seldom hears, form staple articles of trade with the men of Birmingham; and in a late ramble along the streets, for the first time, we could not avoid being struck with this peculiarity. Nothing appears to come amiss in the way of trade; and amongst the forests of signs adorning the streets, we observed, "maker of felons' leg-rings and hand-cuffs," "maker of smoke-jacks," "maker of dolls' eyes," whilst "diamond merchants," "mother-o'-pearl merchants," and "dog-collar makers," were to be seen in great profusion.

The great secret of the success of the Birmingham manufacturers, appears to us to be their possession of an extensive power of adaptation to the requirements of the day. Once a lucrative branch is struck upon, they work it up to its extent, and are again ready, upon the least sign of a falling-off, to direct their means and energies to some other pursuit, probably of a totally different class, demanding a different system of management; in short, imposing upon them the necessity of a complete change of business routine. We wonder at the facility with which this is done, and we admire the flexibility of disposition which permits it. In Birmingham, the shoe-buckle and button had their origin; and all the world knows how industriously these two manufactures were prosecuted there, amidst the vacillations of the tyrant—Fashion. The shoe-tie and boot have abolished the larger buckles, and the trowser has performed the same office for the smaller class pertaining to the knee. Cloth buttons, and the various novelties of modern days, have in like manner tended to drive away the metallic button, so that it became necessary to find a new outlet for the labour hitherto bestowed upon these articles—and with a ready versatility, steel-pens were brought into vogue. This manufacture has risen at a rate quite unparalleled in commercial history. The substitution of sturdy metal for a goose-quill was so original, and the productive machinery so difficult to perfect, that single pens of good selection at one time commanded high prices; now a gross may be bought for a few pence. In Mr. Gillott's celebrated establishment, 250 hands are employed on this simple article alone, and hundreds of tons of steel are yearly worked up in the manufacture. We were refused admission to one of the oldest factories of the kind, Mr. Mitchell's; but have to acknowledge the politeness of Mr. Bradford, of King Alfred's Place, in showing us the whole of his arrangements. The machinery is of the simplest kind, and consists of little more than a series of adaptations of the ordinary fly-press. The steel, rolled out into thin sheets, is stamped out into flat blanks of the size of the intended pen; another press cuts out the piece at the upper end of the slit, and a third bends the flat blank to the semi-barrel form, whilst the last makes the slit. The pens are afterwards ground transversely at the point, brouzed, or finished up in various ways to suit the prevailing taste. It is in the formation of the slit that the greatest ingenuity is required, as it is no easy matter to make a long clear and even slit, coming right to the point, leaving no more metal on one side than on the other. In the same establishment, we saw the process of glass-headed button-making. The coloured glass is purchased in thin sheets, having a coat of amalgam on one side. It is cut up by a diamond into the size and shape required for the button face, and attached by solder to the face of a brass blank previously prepared with a shank. The button is then finished by grinding and polishing on a wheel. Nearly the whole of this work, as well as the several operations in steel-pen-making, are performed by children. In fact, many of the manufactures are carried on, not in regular factories, but in the detached dwellings of the workmen themselves. The artisan procures an order from the merchant or agent, and this he executes at a certain rate, in place of being employed at a regular salary. In cases where the nature of the work renders it necessary, the workman avails himself of the conveniencies afforded by buildings fitted up with steam-power, lathes, and grinding-stones, the rooms in which are let off for short periods to suit different manufactures.

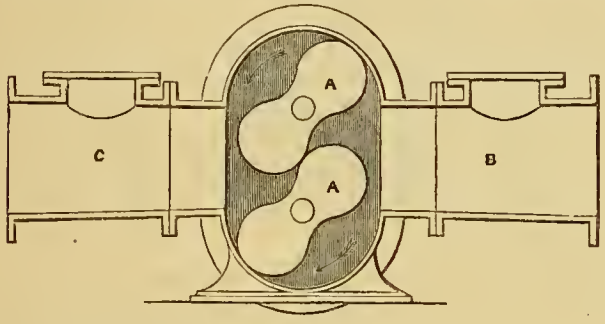
By reason of the minute subdivision of labour, and the great variety of operations involved in the staple manufactures, the operatives are less subject to extreme reverses by depressions in trade; for in most families the members have each a separate occupation—therefore, when one branch suffers, another may be prosperous. Perhaps in no town in Great Britain is the relation between master and workman so intimate as in Birmingham, as the population combining both characters, forms the major portion of the whole. Elkington & Mason's electro-plating and gilding establishment has often been described. It is an example, on the largest scale, of the valuable result of an accidental observation. The fact of the accurate copying of surface, by the deposition of copper in the cell of a battery—laid hold of, and philosophically argued—has given rise to the endless series of "scientific applications" which Messrs. Elkington & Mason have so energetically carried into effect.

The papier-machê manufactory of Messrs. Jennens & Bettridge is another example of an art almost indigenous to Birmingham. Coarse porous bluish paper, pasted sheet upon sheet, is here made to produce a material at once light, strong, and easily workable. Amongst the curiosities of the establishment, were some drawing-room chairs, made of paper pulp pressed into moulds, every part, legs and back, of which, was built up of it. In the ornamentation of papier-machê work, very considerable artistic talent is employed for the inlaying of pearl, the attaching of gold leaf, and the copying and reducing of pictures by eminent painters. Landseer, Frank Stone, and others, owe something to this vehicle for extending and popularizing their works.

At Mr. S. Butler's wire-works, in Summer Row, we saw some copper wire-cord manufactured in a peculiar manner. In all wire-cords, whether intended merely for domestic purposes, or for the heaviest haulages, the

strands have hitherto been combined by twisting only, as in hemp rope-making, and a considerable reactive twist invariably results from the elastic nature of the metal. To remove this objection, Mr. Butler plaits his wires upon a hemp nucleus, and thus forms a stout cord without any twist.

Amongst other things, Mr. Thornton, the present mayor of the town, showed us, at his works in Bradford Street, a novelty in the shape of a hydrostatic jack, invented by Mr. Simmons. The base is made hollow, to act as a reservoir for the water; the cylinder is cast upon this, and occupies the place taken up in the common jack by the elevating screw. The elevating catch is formed upon the upper end of the plunger rod, and a small brass pump is screwed on the side of the cylinder, and gives motion to the ram in the same manner as an ordinary hydrostatic press. The actuating lever of the pump oscillates on studs carried by the main cylinder; the whole apparatus being fully as portable as the common screw-jack. One man may easily raise from 15 to 20 tons by this jack—four or five times as much as he can move with the screw. At the works of Mr. G. Jones, engineer, in Lionel Street, we saw a clever gas-exhauster, which we have engraved, so as to afford its own explanation. Our view annexed, is a vertical section of the case, showing the exhausting pistons, A, in elevation. The case is oblong, with rounded ends, of such a size that the two pistons, A, will revolve together just free from actual contact with its interior surface. The arrows point out the direction of movement. B, Is the inlet passage, and C, the outlet. The pistons are of cast-iron, hollow, and as light as possible.



1-16th.

Some nicety is necessary in setting out the line of curvature, so that the convex ends of the one may fit accurately into the centre concavities of the other. The driving motion is given by a pulley on the shaft of the lower piston, which shaft enters the case by a stuffing-box. The contrary ends of both shafts are geared together by toothed pinions of equal size, so that the two are always kept in the same relative position. It has been improved and practically introduced by Mr. Davies, the inventor of the rotatory engine elsewhere described. We may be able, in a future number, to give particulars of the performance of this apparatus as applied both for blowing and exhausting.

Die-sinking and stamping in metal are very extensively practised in Birmingham. The production of dies for work having a high degree of relief, involves great labour, as well as mechanical and artistic skill of no ordinary degree. In the establishment of Mr. Wilkinson, in Bread Street, we saw some large examples of dies, intended for the relief-work of salvers and dishes, where the depth of the intaglio die from the face was, in some parts, not less than 1½ inches. The steel intended for the die surface is welded, at a high heat, into a large rough mass of iron as a support; it is then annealed and faced, ready for the engraver. Where much of the material has to be cut away, the lathe is often made use of to clear out the cavity, so as to leave less work for the fine tools of the engraver. In the species of work we have described, the engraver works out his design in intaglio, taking impressions, from time to time, in clay or fusible metal, as a test of progress. The reverse for stamping into dies is of several kinds of metal, called the force, as lead, tin, copper, iron, and, in many cases, steel, at times poured into the die, at others raised from the flat, which impression is then used for giving relief to metal. The hollow metallic handles for table cutlery are produced in this manner, being stamped in two halves, which are subsequently joined by solder. The ornamental portions of lamps and chandeliers are examples of the same process.

Statistical notes show us that the mortality in Birmingham is much less than in many other large towns with a less dense population. To account for this, we have to remember that it holds a very elevated situation, and the soil upon which it stands is dry and porous. The pavement of St. Philip's church, which stands in the centre of the borough, is no less than 475 feet above the level of the sea; and the churchyard of St. Paul's is 50 feet higher than the cross of its metropolitan sister. An excellent and cheap water supply is also to be looked upon as one great source of health.

In places of public amusement, Birmingham is not very rich; but it possesses a large share of good architecture in its institutions. The town-hall, in New Street, erected by Messrs. Hansom & Welch, claims the first notice. It is modelled from an ancient Grecian temple. A splendid range of Corinthian columns, of Anglesea granite, supported on a rustic basement, extends along the front and two sides of the building. The hall is one of the finest in the kingdom, being in length 145 feet, breadth 65, and height 65 feet, thus enclosing a space of 600,000 cubic feet. In a recess at the end stands the magnificent organ constructed by Mr. Hill, described by us at a former period. Another magnificent building is King Edward the Sixth's School, erected by Mr. Barry. It is in the Gothic style, and somewhat resembles the general features of the Houses of Parliament. In addition to these, Birmingham possesses two public hospitals, a school of medicine, known as Queen's College, and a splendid market-hall, noted as one of the finest in the kingdom.

In throwing together these desultory notes, we trust we have shown that this seat of the metal manufacture is something more than the "toy-shop of Europe;" and that it owes more to the untiring energy of men like Baskerville, Boulton, Watt, Taylor, and Priestley, than to any mere accidental advantages of position or patronage.

Pittsburgh in America, and St. Etienne in France, have been styled the Birminghams of their respect countries. Both aim at the same productions, but neither of them is so much confined to one class. St. Etienne manufactures guns in great quantities, but it also spins and weaves, and Pittsburgh works chiefly in iron; whilst Birmingham carries on about 150 different branches of manufacture, from a pin to a steam-engine. The combined population of the two places is not more than half that of Birmingham, and certainly both fall far short of it, as well in extent as in variety of manufactures.

LEADEN SHOT AND FOWLING-PIECES.*

Of the origin of small leaden or dropped-shot—perhaps the simplest, and certainly the most purely philosophical, of manufactures—little or nothing is known. This is to be regretted; for a knowledge of the thoughts and circumstances that led to, and attended its development, would have been exceedingly interesting.

In other departments of metallurgy, workmen toil with many tools to mould, cast, turn, hammer, and file substances into desired forms; but the modern shot-maker, as if soaring in science above his neighbours, as well as operating over their heads, mounts a tower, and listlessly pours his metal into free space, confident that, as it falls, nature will break and mould it into the form he wants, while he stands looking on. Nor is he disappointed. By the same law that spherules of dew, of hail, and rain are shaped, shot is made—the law by which the materials of the sun and moon, the globe we inhabit, and all the mightiest and minutest orbs, whirling through the heavens, were gathered round their common centres. Of creation's paramount influence, and its operations in space, what more beautiful illustration! The artist imitates his Maker; for of what is the universe composed, but of variously-sized shot, dropped from the hands of the Deity?

The facility with which streams of metal are changed, in this way, into spheres, the accuracy of outline, and beauty of finish attainable, are remarkable. But for immediate oxidation, the surface of the globules

* From the *Franklin Journal* for November, 1848.

would be smooth and bright, as those of water or quicksilver. Whether the invention came in with the matchlock from the east, or is a European one, has not, that I am aware of, been ascertained. Some persons have supposed that Watts of Bristol, who patented a process for making it in 1782, was the first maker—a great mistake. His mode differed in nothing from the ancient one, except in dropping the fused metal from greater elevations than had been the previous practice. "For small shot," he says, "10 feet, and for the largest, 150 feet, or more."—(*See Rep. Arts*, iii. 1795.)

That this missile was an early accompaniment of portable fire-arms is pretty evident; but the date of its appearance, and the name of its author, are under a cloud.

That primitive muskets were devised to kill men, and, for a while, confined to that purpose, is probable; but their application for destroying smaller game was too obvious to be overlooked. Beckman says they were too long and heavy to be fired without a prop, and were *first* used in war at the siege of Parma, in 1521. Not so. Edward IV. had 300 Flemings in his service, armed with them, in 1471. They formed part of the armament of Columbus; and, further, soldiers are repeatedly figured in the act of firing hand-guns, without rests, and with trigger-locks, taking sight, and handling them like modern troops, in the German translation of Vegetius. (*Enffurt*, 1511.) They appear there as common as artillery, of which greater varieties are portrayed than are now in use.

There is a passage in Petrarch's "Phisicke against Fortune,"—("Englyshed by Thomas Twynne," Lond. 1579.) which implies that, in his day, they were common. He died in 1374. It occurs in the 48th dialogue, when "Reason," remarking on personal arms, says:—"A father can leave none other inheritance to his sonne than he hath, to wyt: his bowe and arrowes, his *piece*, his shielde, his swoorde, and wane, and that also which maketh up the game, his golden spurres."

Now *piece* was the old technical name for portable guns—hence, as their varieties increased, arose "wall-pieces," "birding-pieces," "fowling-pieces."

The 99th dialogue is "On Engines and Artillerie." One passage, though not relating to the special object of this paper, is worth extracting:—

"*Joy.*—I have innnmerable engines and artillerie.

"*Reason.*—It is marueyle but thou hast also pellets of brasse, which are throwne foorth with terrible noyse of fire. Thou miserable man, was it not yenough to heare the thunder of the Immortal God from heaven? O, crueltie joyned with pryde. From the earth, also, was sent forth unimitable lightning, with thunder, as Virgil sayth, which the madness of men hath counterfeited to do the like: and that which was woont to be throwne ont of the cloudes, is now throwne abrode with a *wooden* (?) instrument, but of a deuylish deuice, which, as some suppose, was inuented by Archimedes, at what time Marcellus besieged Syracuse. Howbeit, he devised it to the extent to defend the libertie of his citizens, and to anoyde or defende the destruction of his country, which you now use to the snbiection or subuertion of free people. *This plague of late dayes was but rare*, insomuch as it was behelde with great woonder; but now, as your myndes are apt to learne the worst thyngs, so *it is as common as any other kind of munition.*"

This extract removes all donht respecting the "Crakys of War," alleged to have been employed, in 1327, by Edward III. in Scotland, and snbseqnently at Cresci. Chaucer speaks familiarly, too, of "gonnes."

Hand-guns, apparently with matchlocks, were in use by English gentlemen and yeomen under Henry VII., and must have been rather extensively used in fowling, and killing small animals; since a stringent game law, passed in the 6th year of Henry VIII., repeals "former statntes touching shooting with cross-bows and hand-guns," and enacts that whoever keeps in his house, or shoots with a hand-gun, shall forfeit it, and pay "ten ponnds for every shoot," unless he have a yearly income of three hundred marks.

In the 33d year of Henry VIII. fresh regulations were made respecting "hand-gnns, hagbnts, or demy-hakes." The former were to be a yard long, the latter three-qnarters. The preamble states that people went about with "little short guns, and little hagbuts, furnished with gunpowder, fire, and tonch." All persons were prohibited to kill fowl and deer with them, except snch persons as were worth, in land, a hundred ponnds yearly. One section applies to the *makers* of them. From the expression, "fire and touch," it wonld seem that the flint-lock was not then known, or bnt little known, to British sportsmen.—(*See Keble's Statutes at Large*, Lond. 1681.)

Up to this time, (1542,) there is no intimation of dropped-shot, and we are left to conjectnre what the missiles were which fowlers used. "Half-shot" were in vogue; and they, I suppose, were small bullets or hnck-shot. It appears, however, that dropped-shot was known towards the end of the reign of Henry VIII., since it is expressly mentioned, and by its old characteristic name, in a law passed in the second year of Edward VI.

"Whereas, an act was made in the 33d year of the late king of famous memory, Henry VIII., for some liberty to shoot in hand-guns, haques, and harquebuts; by which act it was provided, that no person should shoot in any of the above said pieces, hut at a bank of earth, and not at any deer or fowl, unless the party might dispend an hundred pound by the year. Forasmuch as the said act having been devised, as it was then thought, for necessary exercise, tending to the defence of the realm, is grown sithen to the maintenance of much idleness, and to such a liberty, as not only dwelling-houses, dove-cotes, and churches, are daily damaged by the abuse thereof, hy men of light conversation, *but that also there is grown a customable manner of shooting of* HAIL-SHOT, whereby an infinite sort of fowl is killed, and much game thereby destroyed, to the benefit of no man; whereby, also, the meaning of the said statute is defrauded, for that the said use of *hail-shot* utterly destroyeth the certainty of shooting, which, in wars, is much requisite: Be it therefore enacted, that no person, under the degree of a lord in parliament, shall, from henceforth, shoot in any hand-gun, within any city or town, at any fowl, or other mark, upon any church, house, or dove-cote. Neither shall any person shoot in any place, *any hail-shot*, or any more pellets than one at one time, upon pain," &c.—that is, a fine of ten pounds for every shot, and three months' imprisonment.

A second section declares the above is not to prejudice the rights of those allowed to shoot hy the 33d of Henry VIII., the use of "*hail shot* excepted, as, indeed, *that kind of shot* in the said act was not meant."—(*Statutes at Large.*)

From the last remark, the inference is, that this shot was introduced into England, if not invented there, between 1542 and 1548.

The objection, that the substitution of a number of shot for a single one, would diminish the previous accuracy of aim, was well taken. It is doubtful whether modern sportsmen equal—they certainly do not surpass—their predecessors in this respect. Shooting game flying, with the bow, was quite common; but the perfection of fowling was to hit a bird on the *bill*, so as not to lacerate the body. This was beating the old marksman, who addressed an arrow to Philip's right eye.

In the 1st of James I. cap. 27—another severe game law—hail-shot is forbidden to be fired from "hand-guns or birding-pieces," except by persons duly licensed, and then only to kill "crows, pyes, rooks, ring-doves, jays," &c., "for hawk's meat only." Here, again, the old hand-gun is a regular fowling-piece. When Falstaff proposed to hide himself in the obimney, Mrs. Ford told him that would not do, as "there they always used to discharge their birding-pieces." The same hero describes his recruits as starting at the report of a caliver—a sportsman's gun—"worse than a struck fowl, or a hurt wild-duck."

The oldest direction for making hail-shot that has fallen in my way, dates no further back than the middle of the 17th century. It is professedly copied from previous writings. The essential parts run thus:—"Melt lead down in an iron kettle, skim it, and when 'tis so hot that it begins to turn greenish, strew as much fine powdered auripigmentum (arsenic) upon it as will lie upon a shilling, to every twelve or fifteen lbs. of lead, which then must be stirred well, and the auripigmentum will flame. A little may be taken out in a ladle for an essay, and which, when reduced to a proper heat, may he dropped into a glass of water. If the drops prove round, and without tails, there is auripigmentum enough therein, and the temper of the heat is as it should be; but if otherwise, more auripigmentum must be added, and the heat augmented till it be found right."

Directions then follow, to pour the metal through a perforated dish in the usual way, and to sort the shot by means of sieves.

The most remarkable part of the direction is the short space the metal fell through. The perforated dish was "placed in two bars, or other iron frame, over a tub of water, about *four inches* from the water." No wonder "the greatest care was to keep the lead at so moderate a heat, that it be not too cool to stop the holes, nor too hot, which will make the drops crack and fly; for the cooler it is, the larger the shot will be. Such as will have very large shot, make the lead trickle with a stick, out of the ladle into the water, without a [perforated] plate."

It would be difficult to point out, in the records of the arts, an example of dulness in old workmen so gross as the history of hail-shot exposes. For about 240 years previous to Watts' improvement, its fabricators dropped it close to the vessel of water prepared to receive it, while every ounce they made was attended with embarrassments that loudly suggested a greater fall. Had they melted the metal on a second floor, and poured it from the window, an amount of trouble and mortification would have been avoided, which no one, not practically acquainted with its manufacture, can appreciate. I know not how to account for the fact,

unless hy supposing no manufactory of any consequence was estahlished to supply the public, and that sportsmen were in the habit of making it for themselves.

That huck or cast shot sometimes went hy the name of hail-shot appears evident. In 1594, some English sea-rovers, under James Lancaster, took Pernambuco. The writer of the expedition, in Hakluyt, says, their muskets were provided with "haile-shot, whieh severely gauled the Iudians and Portuguese." That this was not dropped-shot, appears from his next sentence. "And this is to he noted, that there was hoth the horse and his rider slaine with one of these shot."

E.

LOCOMOTIVE PASSENGER-ENGINE "JENNY LIND."

Illustrated by Plates 23, 24, 25, *and* 26.

The three plates of this engine, which we now present in connection with the longitudinal section, plate 23 of last month, leave little to he told in the way of a description, as they afford an exposition of their details in themselves. In establishing this class of engines, Messrs. Wilson have studied less the introduction of dangerous novelties, than the judicious combination of isolated examples of well-tried contrivances. Plate 24, is an external elevation of the engine in complete working order. Plate 25, is a transverse section, taken at two different parts, showing one half-section through the fire-hox and safety-valve funnel, and another through the smoke-hox, cylinders, and chimney. Plate 26, is a similar section through the cylindrical portion of the boiler, at the part where the steam-dome is fixed, and showing the crank-axle in elevation.

The method of attaching and carrying the cylinders is deserving of especial notice, for its efficiency in preventing all the oscillation so frequently arising from side strains. In the centre, they are held together hy their own joint flanges, and on the outside of each a deep flange is cast on, for bolting to two inner wrought-iron longitudinal frames running parallel with the maiu-axle framing, from fire-hox to smoke-box. The same frames carry the horn-plates of the crank-axle, which runs entirely free of the outer frame. By this arraugement, the strains of the cylinders are resisted hy the inner frames alone, which are well bracketed or stayed from the boiler. The slide-valve faces aro vertical, as is now usual in the hest engines; they are compactly placed, and no iujnrious deposit of foreign matter can take place upon them.

The link-motion of the valves is fully explained in the longitudiual section, plate 23. The link is suspended from the centre, and is well equipoised to work with a minimum of resistance.

The feed-pumps arc holte l hy long flanges to the outside of the fire-box, just within the line of the outside frames. This position is perhaps the hest that could be selected; they are easily accessible for examination or repair, and the heat from the fire-hox will always prevent stoppages hy frost. The pump-plungers are of large diameter, cast hollow, with a connecting-rod jointed iuside, for attachment to a pin on the outside of the driving-wheel.

Without entering further into the details of the machinery, we may state, that the remarkable steadiness of these engines has fully proved the correctness of the views held by her originators. We have before remarked upon their performanees, as ranking with the hest on record, and future results will not be forgotteu iu the *Practical Mechanic's Journal.*

ANATOMY OF THE PHYSICAL STRUCTURE OF THE UNIVERSE.

By Mr. R. Smith, Blackford.

No. VIII.—Heat.

The term *Heat* admits of many definitions. It has reference as well to the sensations of our hodies, as to the state of suhstances which produce snch sensations. The French chemists have restricted the word heat to the sensation produced, whilst the cause has heen marked hy the term caloric. All our information on the suhject of heat has reference only to its effects; and in the material universe we see these effects on all sides. Heat is actively engaged in the production of expansion, vaporization, fluidity, ignitiou, and comhustion. Owing to its diffusion throughout the earth and atmosphere, liquids are kept in a fluid state; an additional quantity of heat causes evaporation; a dimiuution, coudensation, effecting the formation of the falling drops of rain, the spherically-formed hail, the fleecy suow-flake, and the sparkling crystals of hoar-frost. If the heat were ahstracted, or considerahly diminished, plants and animals would cease to live; the oceau would become a rock of ice, whilst the earth itself would he shrouded in eternal snow. But the Projector of the universe has so uicely halanced his compouent materials, that all is in harmouy.

The earth receives its heat from the sun, in association with light. During a warm day, the surface of the earth ahsorhs large quantities of caloric; and, remembering this, it would at first appear that, in the ahsence of the sun at night, the atmosphere, owing to the earth's abstraction of its heat, would he extremely cold. To some extent this is the case, hut the change is modified considerahly, hy the earth's giving back to the atmosphere a quantity of its ahsorbed heat—in this mauuer restoring the equilihrium. On the same principle, the seasons of summer and winter are brought nearer to an equal temperature; the solid earth retaining a greater quantity of solar heat than the air, it gradually imparts it to the latter during winter. In summer, the greater portion of the earth is covered with a green colour, and consequently its ahsorption of heat is less than if darker tints were present; whilst, during winter, the uniform dark-hrown colour absorhs a greater amount. With few exceptions, hodies are capahle of expansion by heat. The most expansive bodies are gases; after them, liquids; then solids. One of the hest illustrations of the expausion of aeriform bodies, is the old one with a hladder partly filled with common air. If this is held before a fire, the small quantity of contained air gradually increases in hulk, until it completely distends its case; aud if the heat is increased, the memhrane may he hurst. Iu liquid expansion, if a numher of glass tuhes with bulbs at their extremities are filled with alcohol, water, oil, and ether, respectively, and placed with their hulhs in hot water, all the different liquids will expand and rise in their tnhes with different degrees of rapidity. The cause of this difference in expansihility is said to he unknown; but an opinion on the point may he ventured here. Philosophers agree that expansion occurs from the entry of that subtle agent, caloric, hetween the particles of matter, forcing them asunder—overcomiug the attraction of cohesiou, and consequently dilating the bulk which they make up. Now, if this is really the cause of expansion, it may he argued that the thinner and lighter the matter is, the more easy will be the task of separation of the particles, as the caloric will enter between them so much the more freely. In support of this theory, it is to bo kept in view, that gaseous hodies are lighter than either water or alcohol, and the former are more expansive. Again, sulphuric acid is deuser than water, and the former is the less expausive of the two.

The degrees of heat and cold are measured hy an instrument to which the name thermometer has heen given. The principle of expausion of liquids is here hrought into play for a useful purpose: the level of the mercury contained in the tuhe rises hy ahstracting heat from the air, or any other medium with which it is in coutact, and again falls by the communication of the heat. In this way the degrees of heat are accurately marked; but of the amouut of heat contained in any body, it takes no cognizance.

The expansion of heated solids is easily ascertained hy fitting a rod of iron, with a ring of the same metal, in a cold state; when the rod is heated, it will he found so much expanded that it will uot enter the ring. A practical illustration of the effects of this expansion is to he found in the wheelwright's shop, where, in puttiug on the tyre of a cart-wheel, the tyre is heated to redness, and then slipped upon its hearing, water heing poured upon it to bring ahout a contraction of the metal to bind the whole together.

Vaporization is the philosophical term used for denoting the process of conversion of liquids, as water into steam. When water is hoiled in a vessel exposed to the ordinary atmospheric pressure, its hoiling point is 212°; and although we apply an additional heat to the vessel, the temperature of the water will uever he elevated, as the particles of the liquid separate from each other, and become vapour. This vapour is 1696 times greater in hulk than water, and may he again eondensed into water hy mechanical pressure, or hy removing the heat which has caused the repulsion of the particles. If we remove the pressure of the atmosphere from the water, it will hoil at a temperature much lower than 212°. To show this, take a phial, half full of water, and heat it to the atmospheric hoiling poiut in a sand hath; after which, cork it securely and immerse it in cold water. The action of the external cold will now cause the water in the phial again to hoil, hy condensing the vapour contained in the upper portion of it, and thus removing the atmospheric pressure; if it is again placed iu hot water, the ehullition ceases. Were it possihle to remove the entire atmospheric pressure from the earth's surface, all liquids would begin to boil at the ordinary temperature of the atmosphere. Another branch of our suhject involves distillation, which is simply the conversion of liquids into vapour, which is again condeused into a liquid hy the application of cold.

Spoutaneous evaporation from the surface of the earth and sea forms clouds, which arc condensed into rain, dew, &e. Evaporation always produees cold, the heat necessary for its production heing derived from ohjects in its ueighbourhood. As an illustration of this principle, take

a small glass tnhe closed at one end, and having a small quantity of water in it. Then, hy a dropping tuhe, let fall some sulphuric ether, or sulphuret of carhon, on the outside of the water tuhe, and the water will be converted into ice—the evaporation of the ether rohhing the water of a proportion of its heat.

The inhahitants of warm climates take advantage of this in cooling their heverages. By wrapping the coutaining vessels with wet cloths, and exposing them to the sun's heat, the rapid external evaporatiou produces sufficient cold to reduce the temperature of the liquid in the vessel very greatly. From the few remarks we have here made, it will he seen how intimate is the relation of heat with the states and forms of hodies; for hy it gases are expanded, liquids converted into invisible elastic fluids, and solids hecome liquids.

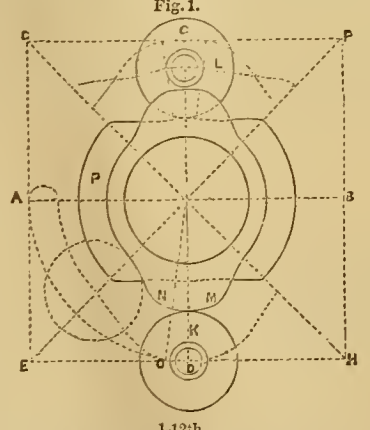
In the search after the fundamental origin of heat, three theories have heen started—the emission, vihratory, and electric. According to the emission theory, heat is supposed to he a material suhstance or fluid, emitted from the sun, and which passes throngh transparent media, such as air, with great rapidity, aud is either ahsorbed hy the hody upon which it falls, or is reflected hack from it. The vihratory theory presumes it to he produced hy a series of waves or vihrations in the particles of matter, or molecules of bodies, which is caused hy the direct action of *some unknown force*, propagated from the solar orh. In the electric theory, heat is snpposed to he one of the modifications of the suhtle fluid, electricity. We noticed, in our introductory paper, the presumed connection hetween light, heat, and electricity, and need not further mention it here.

DAVIES' ROTATORY ENGINE.

(Concluded from page 252.)

The five illustrative figures of this engine, given in the last part of this Jonrnal, have, perhaps, sufficiently explained its general claims to public favour; we have now only to add a hrief exposition of some of the more valuahle details of eonstruction which the plan emhodies. In Mr. Davies' later patent of 1848, the single-acting pistons described in our first paper have heen replaced by douhle-acting ones, having two actuating projections npon them, in place of one. The two projections are set opposite to each other on the pistons, the latter heing so placed on the shaft, that the projections of each, stand at right angles to one another, thns halancing hoth their own weight and the actuating pressure of the steam. Steam-stops, with the requisite valves, are provided for each projection, on opposite sides of the engine, the two stops for oue piston heing simultaneously worked hy one cam motion. In place, therefore, of describing the single motion of the former engine, we shall explain that adapted for the engine with duplex projections. Fig. 1 exhihits a side elevation of this arrangement, in which the two dotted lines, A B, C and D, are supposed to stand in planes coincident with the centre lines of the piston projections. The throw of the cams having heen settled, the first thing to be done in setting out their curves, is to form the dotted square, E, F, G, and H, with diagonals drawn throngh it. To find the diameter of the anti-friction rollers, K, L, against which the cams act in working, the throw of the cams is added to the thickness of the roller studs, allowing abont one-eighth of an inch clearance hetween the extremity of the cams and the roller stnds. The true curve of the actuating cam surface is a matter of great nicety, as npon its exactitude depends the correct working of the valve-stops against the piston projections. The hreadth of the end, M, N, of the smaller cams, is determined by the piston projections themselves, as the two must correspond. On moving the rollers in the direction of the arrows, it is evident that no rectilineal motion will take place, until the point N is gained, and the nature of the movement, snhsequent to this, is thus determined. On the horizontal line, A B, a semicircle, with a radius equal to half the throw, is delineated at A, and this is divided into any given numher of equal parts, and from these points ordinates are drawn to the diametrical line.

Fig. 1.

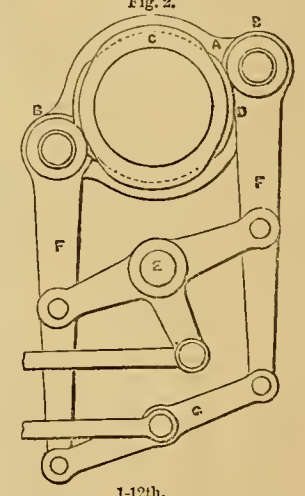


1-12th.

Then from the centre of the shaft, the arc A D is described, heing hisected hy one of the diagonals before mentioned. That portion of the arc contained hetween the point, O, and the diagonal line, is divided into the same numher of parts as the semicircle at A, drawing radial lines to each, and describing concentric arcs, commencing at the end of the ordinates of the semicircle, A. A line then traced through the points of intersection of these arcs with the radii, will indicate the centre of motion of the traverse of the roller, D, the periphery of which gives the required shape of the cam. The larger cam, P, is of course formed so as to act in concert with the small one, which we have just described.

In the single-acting engine of Messrs. Edelsten & Williams, no provision is made for working expansively, but, in the improved modification, this is added in an efficient manner. Fig. 2 is a front elevation of the cams employed for this purpose, together with the adjustable mechanism used for altering or setting the amount of lead and expansion of the valve. Immediately outside the cams for working the steam-slide, two connecting plates, A, are placed on the shaft, enclosing a pair of rollers, N, B, which revolve in contact with the two cams, C and D, the curves of which are similar to those of the steam-slide. On a fixed shaft, E, helow, is fitted a bell-crank lever, the length of the straight arm of which is equal to the length of a line drawn hetween the centres of the rollers, N. The ends of this arm are jointed to the longitudinal centre of the perpendicular links, F, F, which are further connected at their lower ends hy a link, G. The whole thus forms a parallel frame, supported on the fixed shaft, E, upon which the whole oscillates when set in motiou hy the revolution of the two cams. The movement is communicated to the expansion-valve, by a rod attached to the centre of the link, G; and a second rod attached to the hell-crank on the shaft, E, serves to set the frame in any position to suit the required lead and expansion of the valve, as, by drawing the rod in or out, the rollers, N, B, are moved round their cams, just as an eccentric ring would be moved over its disc, by the revolution of its rod round its centre. The expansion-slide for each cylinder is placed heneath the working steam-slide, a channel passing from it heneath the cylinder to the opposite steam-slide, so that one expansion-valve and gear answers for the two steam-valves.

Fig. 2.

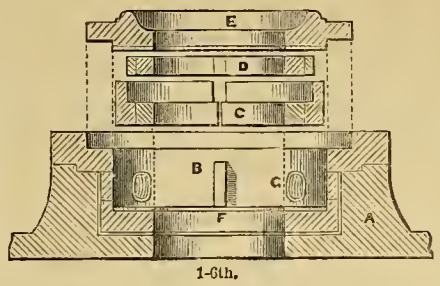


1-12th.

Referring to our previous illustrations, it will be seen that the actuating projections upon the pistons, which work up against the circumference of the cylinders, are fitted with a packing piece of metal, M, placed ohliquely across the face of the projection, to facilitate its passage across the slot in the cylinder. This stop-piece is kept up to its working face hy the pressure of the steam hehiud it, a slight hlade-spring being provided as an additional safeguard. The action of the cam motion is such, that at each revolution, when the projection, M, approaches the steam-slide, the latter is drawn hack at such a rate, as to keep its inner faced end just clear of the approaching curved surface; and just at the instant of the passage of the face of the projection, the slide for an instant stops, and is then similarly pushed inwards, to fill up the space gradually left hy the receding of the projection. The working face end of the steam-slide is fitted with a tongue-piece of brass, with a spring behind it, to work upon the cylindrical portion of the piston. The action of this tongue is clearly shown in the details, figs. 4 and 5, *ante*. To support the slide against the pressure of the steam, when stretched across the annular space of the cylinder, it is let into a groove in the centre partition, and end set-up plates, thus providiug it with a solid foundation. The adoption of the system of divided steam-ways in the slide, removes all ohjectionahle frictional wear at that part, as it is only for a quarter of an inch movement in each stroke that the steam pressnre upon the valve is unhalanced. The instant the communication is opened on hoth sides of the stop, the pressure is equipoised, and the remainder of the valve's stroke is performed under a pressure no greater than that resulting from the mere weight of the metal. At each revolution, a portion of the steam contained hetween the after curved side of the projection and the cylinder, which steam has before done its duty in carrying round the piston, is shut in by the steam-stop, to be again made use of in the succeeding stroke, or revolution. One of the many valuahle details of the engine is the metallic ring packing, em-

ployed as a stuffing-box, for passing the main shaft through the cyliuder end covers. Figs. 3 and 4 represent this contrivanee very fully. Fig. 3 is a sectional view of a portion of one of the end plates of the cylinder, with the packing rings removed; fig. 2 is a plan of the same: A, is the cylinder cover, bored to receive the cast-iron packing-box, B, which is bolted to the cover by a top flange, whilst the shell portion does not come in contact with the cover, a space being left between the surfaces for the admission of steam between them. The detached brass segmental rings, C, fit into the interior of this box; these rings have a step turned out of their upper side, for the reception of the smaller segmental rings, D, over which the gland, E, is bolted. The box, B, is fitted with two projecting feathers, F, which enter grooves cut on the outside of the larger segments, C, which are thus prevented from moving round in their places. On the outside of the shell of the box, B, are four projections, G, bored to receive spiral springs, which abut against the outside of the segments, so as to press them in close contact with the shaft passing through them. All the segments are accurately turned, to fit well upon one another, but allowing space for a movement of an eighth of an inch inwards and round. This packing has been in action on the revolving shaft of the rotatory engine ever since the latter commenced working; its efficiency has, therefore, been proved. We have also witnessed its action on the piston-rod of a reciprocating engine of some six inches in diameter. This was on the large engine of the Battery and Metal Works, Digbeth, Birmingham, where it was substituted for a hemp stuffing-box of the old construction. Here it worked with the most desirable smoothness, and answered in every respect as a truly steam-tight packing. From the peculiar arrangement of the segments, any inequality in the shaft or rod passing through them is excellently compensated for, and binding can never occur.

Fig. 3.



1-6th.

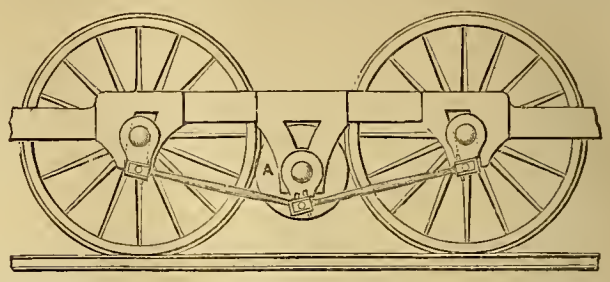
Fig. 4.

The bearings of the main shaft are so arranged, as to admit of a ready re-adjustment for the preservation of the perfect concentricity of the shaft. An iron lining-plate is placed beneath the lower brass, and beneath this a wedge-shaped cotter is passed directly through the carrying standard, so that, by drawing this in or out, the shaft may be elevated or depressed to suit circumstances. A clever little contrivance is attached to the side of the standard, to indicate whether the shaft is working in its true centre. This is nothing more than a short pointer, set loosely on a stud-pin, at such a distance below the shaft, that when the latter is correctly set, it will just pass free of the lower side of the shaft, when turned round upon its centre.

Mr. Davies has constructed a model of his engine, as applied to locomotive purposes, which we have tested upon a short line of rails, inclined at an angle of 1 in 37. Our diagram, fig. 5, will show how the cylinders are adapted for locomotion. They are placed at A, between the leading and trailing wheels, the main shaft being carried by hangers depending from the frames. A single crank is fitted on each projecting end of the shaft, the two being set at right angles to each other. Each of the crank-pins carries two connecting-rods, the contrary ends of which are jointed to outside cranks on the driving-wheels, passing fore and aft. Instead of forming the horn plates for the driving-wheels with straight vertical openings, they are curved as represented, their radius being equal to the length of the connecting-rods. Thus, when play comes upon the springs of the engine, the curved movement of the axle-bearings precludes the chance of any strain upon the connecting-rods, or other adjacent parts.

The model engine ascended the incline of 1 in 37 with the greatest ease, carrying a dead weight of about 300 lbs. Its motion appeared to

Fig. 5.



be beautifully regular, as, from the continuous rotatory action of the impelling power, a straightforward dead pull is gained, unvitiated by any oscillation. The diameter of the cylinders of this model is 4 inches; length, $2\frac{3}{4}$ inches; annular space in which the steam acts, $\frac{1}{2}$ inch; length of propelling cranks, $1\frac{3}{4}$ inches; weight of engine, 240 lbs.; pressure of steam, 65 lbs.; gross weight, 540 lbs.

In order to obtain perfect satisfaction as to the amount of wear upon one of the parts most liable to suffer, we took out the steam-stop of the sister engine of the one at Messrs. Edelsten & Williams' works. This engine has had a good deal of employment for the last two years, in driving the tools of Mr. Davies' workshop; nevertheless, the wear upon the end-face of the adjustable stop-piece in the slide, which works against the piston, was inappreciable.

The boiler driving Messrs. Edelsten & Co.'s engine is cylindrical: 4 feet 9 inches in diameter, and 18 feet long, with an internal oval flue, 2 feet by 1 foot 8 inches in diameter. We simply mention the boiler, to note the effective covering which has been applied to it. A coating of saw-dust, $1\frac{1}{2}$ inches thick, covers the metal, after which is set an arch of bricks on edge, just clearing the saw-dust, the bricks being again covered with a $\frac{3}{4}$-inch thickness of cement, coated with gas-tar.

The regularity of action of the present engine, assures us of the still greater regularity which will result from the use of the duplex pistons. A fly-wheel will not necessarily be required, the steam power being equally effective at all portions of the stroke, whilst the direct rotatory motion accumulates momentum for most efficient distribution. In point of form and general arrangement, the rotatory engine commands every advantage which the best mechanical contrivances ought to embody; and it requires no great sagacity to see how well fitted an engine, like the one we have illustrated, is for marine and locomotive purposes. For the carrying out of the principle of screw propulsion, what movement so conveniently applicable to the screw shaft? For railway locomotion, what so valuable as the continuous rotation here provided? Only a week or two before his death, George Stephenson expressed opinions of a similar nature. Such testimony coming from the author of the "Fallacies of the Rotatory Engine," may well be considered of importance, showing, as it does, that the aim at the obtainment of a *rotatory lever, per se*, has not been entirely in vain. W. Johnson.

OUTLINE OF ASTRONOMY.

No. IV.

The Earth.—(*Continued.*)

Zones.—The direction of the rays of the sun upon the earth has led to a division of its surface into five zones, or circular bands, of which the centre is termed the torrid zone; the two comprised between it and the polar circles are called temperate zones; and those surrounding each pole are known as frigid zones. The breadth of the torrid zone is 46° 56′; and this is divided by the equator into two equal parts. The inhabitants of this zone, directly under the equator, have the two poles at their horizon. All the stars rise and set within their view. Their days are of equal length. Those who are between the equator and the tropics have one of the poles elevated above the horizon, and, for this reason, they do not see all the stars rise and set; and, except at the equinoxes, their days and nights are of unequal length. The temperate zones are each 43° 44′ in breadth, and the sun is never vertical to them. The breadth of the polar zones is 23° 28′. In summer, they have several days without nights; and in winter, several nights without an intervening day. The nearer we approach the pole, the more this occurs. At 66° 50′ of latitude, the sun is invisible at the winter solstice; and the longest night is 24 hours in duration. At 67° 30′, the longest night lasts a month; and at 84° 4′, it is five months long. At the poles, the

whole year is divided into a day and a night, each of six months' duration.

The Year.—At first, the civil year was calculated to contain no more than 365 days; but, as it was discovered that to replace the sun in the same point, such as an equinox or a solstice (this is called the *tropic* year), it required 365 days 5h. 48′ 48″. The accumulation of the fraction of a day was perceived to be important; and, to render our reckoning of time less inaccurate, it was deemed necessary to make every fourth year consist of 366 days, which year we term bissextile, or leap year.* This computation supposes the fraction to amount to a quarter of a day, whereas it is short of six hours by 11′ 12″; and therefore, in the space of four centuries, three bissextile years are suppressed, so that in 400 years only 97 days are intercalated. This rectification of the measure of the year was first made in Europe in 1582; but some similar process was used from time immemorial by the Egyptians. The length of the *sidereal* year (the return of the sun to the same star), is 365d. 6h. 9′ 12″; and we shall soon see the reason of its exceeding the tropic year.

The Zodiac, and the Precession of the Equinoxes.—The zodiac is a broad circular zone or band in the heavens about 18° in breadth, divided throughout into two equal parts by the ecliptic. Within this zone the orbits of all the planets are placed. It is vertically divided into 12 parts of 30° each, denominated *signs*, which derive their names from the constellations with which they formerly corresponded. But the stars have an apparent motion from west to east, because they are referred to the equinoctial points, that is, to the points where the plane of the equator cuts the plane of the ecliptic; and these points having a motion from east to west, it happens that the constellations of the zodiac no longer correspond with the signs. This retrograde motion is termed *the precession of the equinoxes*. This revolution of the heavens is completed in 25,868 years—that is, about 51″ a year, or a degree in 71 years; so that the sign of Aries, which is the spring equinox, is in the constellation of the Fishes, and very near that of Aquarius. The cause of the precession of the equinoxes is attributed to the combined action of the sun and moon on the terrestrial spheroid. By reason of its equatorial expansion, the line of section of the equator and the ecliptic slowly changes in a direction contrary to the order of the signs. The solution of this problem was attended with great difficulty. It baffled Newton, but d'Alembert succeeded completely.

To calculate the precession, we begin by finding the force with which the sun attracts each particle of the earth, then the total force resulting from it which causes the revolution of a meridian, and then the entire spheroid. When we know the force for a given instant, we may ascertain the total motion by means of the integral calculus; and we learn thereby that the terrestrial equator retrogrades about 16″ annually by the action of the sun alone, assuming the earth to be a homogeneous mass. A similar effect is produced by the moon; and the precession thereby occasioned is easily calculated from the action of the sun. But as the moon, by the movement of its nodes,† in nineteen years alters considerably its distance from the equator, and, consequently, the direction and obliquity of its attraction upon the elevated parts of the earth at the equator, it produces not only a continuous retrograde motion, but also a periodical inequality, and a nutation, of which we shall shortly speak. The solar action sending back the equinoctial points 16″ per annum, the lunar adds 35″ to this retrograde motion.

Nutation of the Earth.—The nutation of the earth is a slight gyratory motion observable in its axis, in consequence of which the axis is inclined from the ecliptic more at one time than at another. It arises from the figure of our planet not being perfectly spherical, and the action of the moon and sun upon it being a little different at different times, according to the relative positions of these bodies with respect to it. The force of their action not passing exactly through the earth's centre of gravity, produces in its axis the change in the obliquity to which we have alluded. Bradley was the first to observe this motion, which he found to be a consequence of the precession; and he ascertained that the earth's axis is made to trace, in nineteen years, a small ellipse, of which the axes are 9″6 and 8″4, that time being, it will be remembered, the time of the revolution of the moon's nodes.

The Atmosphere and Astronomical Refractions.—The atmosphere is an elastic fluid, rare and transparent, which envelopes the earth, and rises to a great height above it. Like all material things, it possesses weight; and, at the level of the sea, a column of it is sufficient to put in equilibrium a column of mercury 27½ inches high. As we ascend, its pressure and density diminish, and the column of mercury descends gradually, so that the barometer in which such a column is enclosed has been frequently employed to measure the height of mountains. Were the temperature of the atmosphere always the same, the density of its successive strata would diminish in arithmetical progression, and one might ascertain the height accurately; but, as it is extremely variable, and lessens the higher we go, it is only by approximation that we can judge of the total height of the atmosphere. Calculations from refraction and the duration of twilight, would lead one to suppose it not less than 50 or 60 miles high. Small masses of air are invisible; but the rays of light reflected by all the strata of the atmosphere, give it that blue tint which forms the azure of the firmament. This blue vault, then, in which the stars seem embedded, is in reality quite near us; and if we go to the summit of a lofty mountain, the sky appears of a dark grey, and the stars shine in the middle of day.

If the eye could distinguish and refer to their true place the points of the exterior surface of the atmosphere, we should behold the heaven as a *spherical* vault. But, as the height of the atmosphere, in comparison with the terrestrial radius, is very small, it appears to our eyes like an *elliptical* vault; that is, the distance above our heads seems less than the horizontal distance. The interposition of objects at the horizon is one cause of this appearance. A star, with an altitude of 26°, seems to divide into two equal parts the length of the curve which extends from the horizon to the zenith, whence it follows, that the horizontal radius of the apparent vault is to the vertical about 3 to 1; but this proportion varies with the causes of the illusion. One of these causes is refraction. Refraction is the deviation from their courses in straight lines which rays of light, coming through the atmosphere, are subjected to by the medium they traverse. An observer who sees a star on the edge of the horizon, sees an object which is in reality below it, and which would be invisible to him were the atmosphere removed; and thus we enjoy the rays of the sun a few minutes before that body has actually ascended above the horizon, and for a few minutes after he has descended below it. A very simple experiment will be sufficient to verify this property of refraction. Take a piece of money, and place it at the bottom of a vase; and let the observer retire, until it is just hidden from his eye by the edge of the vase. Then let some one fill the vase with water; and, though the position of the coin has not been altered, he will now be able to see it, because the luminous rays which leave the object in right lines are deflected from their course in passing from water into air, and the image reaches the retina in consequence. It is by the refraction of light that we have been able to ascertain its composition. A beam of solar light sent into a darkened chamber, and made to pass through a prism of glass, forms an oblong image of different colours. The beam being composed of many rays of various colours, which have different degrees of refrangibility, the prism causes them to separate. The most refrangible ray is the violet, then indigo, blue, green, yellow, orange, and red. All these being again united by means of a lens, white light is reproduced.

Twilight is also an effect of the atmospheric refraction. It affords us a gentle and gradual transition from day to night, and from night to day. The dawn commences, and the twilight of evening terminates, when the sun is 18° below the horizon; the duration of twilight in both cases depends on the length of time that the sun takes to travel through that number of degrees, that is, about an hour and twelve minutes. Refraction only takes place when the rays of light are oblique. It is greatest at the horizon, and decreases gradually to the zenith, where it ceases, because the rays are there perpendicular to the surface which separates the two media. An analogous effect is produced by a staff plunged into water, which, when beheld vertically, no longer appears bent. The horizontal refraction is estimated at 33′; that is, when the stars are yet 33′ below the horizon, they become visible. In all astronomical observations, it is necessary to keep this phenomenon of refraction in mind, and to make allowance for it in our calculations.

The Moon.

The planet nearest the sun, after passing the earth, is Mars; but the moon, the earth's satellite, must first engage our attention. After the sun, she is to us the most important of the heavenly bodies, and her motion is quicker than that of any other. Every month she changes figure, and travels round the earth in a direction contrary to the general motion, whilst she appears to rise and set every day like the other stars, travelling from west to east; after a while, she moves slower, and seems to remain behind the stars, or to retreat towards the east. This motion is called her proper, or periodic motion. It is very perceptible, since, in

* To discover whether a year is bissextile, we divide the last two figures by four. If there is no remainder, then the year is leap year; but if there is a remainder, then it expresses the number of years which have elapsed since a bissextile year. Thus, the two last figures of 1849 being divided by four, there is a remainder of 1, which signifies that 1849 is one year from leap year.

† *Nodes.*—The orbit of the moon is inclined 5° 7′ to the ecliptic, and the points of intersection are termed nodes. They are not fixed points, but have a retrograde motion, or a motion contrary to that of the moon. In order clearly to comprehend the meaning of the term, we have only to imagine two hoops, one placed inside the other, but a little deflected from it. The two points where they are in contact will represent the nodes. We term that one *ascending*, when the moon crosses the ecliptic towards the north pole; and the other *descending*, the moon then sinking towards the south pole.

the space of 27 days, the moon, which appeared at first near some particular star, is seen to retire from it, and to move through the heaven in a contrary direction to the diurnal or common motion.

The phases of the moon, or the different appearances of her light, are phenomena well known to our vision. After shining for a whole night in a round shape, broad and brilliant (this is the full moon), she loses, little by little, her brightness and magnitude: she rises later, is only seen for half the night, and resembles a half circle. She is then in her quarters. Some days afterwards, continuing to approach the sun, she is a crescent, which appears before sunrise in the east; her horns upwards, turned from the sun, and still diminishing in size and light, she is lost in the rays of the central luminary. This is what is called the new moon, or a conjunction. Having been invisible for three or four days, she reappears on an evening, in the east, after sunset, and grows into a crescent. Continuing her advance to the east, and her removal from the sun, she increases both in size and lustre. When she is in her first quarter, she is a semicircle, again terminated by a right line. Seven or eight days afterwards, she appears a full and round body as before; and she shows her greatest brilliance and size, because the sun illuminates her in front of us, and not from one side. She passes the meridian at midnight, rises when the sun sets—this is the day of the full moon, or the opposition. The conjunctions and the oppositions are termed *syzygies*.

In observing the moon's phases, we shall perceive that the eclipses of the sun happen between the last quarter of a moon whose course is about to finish, and the first quarter of a new moon; in other words, between the times when the moon, in a morning, approaches nearest the sun, and when it commences, of an evening, to retreat from it on the opposite side. A round and perfectly black body is then seen before the sun; it glides, little by little, before the sun's disk, and intercepts the light, sometimes altogether, but usually only in part. This body is no other than the moon, which we had seen, during the preceding few days, advancing nearer and nearer the source of light, and which one may shortly see appearing on the other side, and leaving it. This phenomenon, coupled with that of the phases, proves that the moon is opaque, and that its light is borrowed from the sun.

An examination of the spots on the moon's disk, proves that we always behold the same hemisphere; and, as this hemisphere ever presents the same aspect from whatever position in the heavens we observe the moon, it has been concluded, that she turns upon her axis in the same space of time that the earth performs her diurnal revolution in. This is not, however, exactly the case; and close attention has proved, that the spots near the edges have a slight oscillatory movement, which reveals them and conceals them alternately. This is called the *libration*; and it was remarked, for the first time, by Galileo. But if the periodical movements, and those of the moon's rotation being nearly isochronous, cause her always to present the same side to the earth, for the same reason she presents to the sun, in the same space of time, all the points of her surface. When she is outside the earth, the side that we see is that upon which the sun's rays fall. When she is 90° from the sun, only half of the side turned to us receives the sun's rays, the rest of them falling upon that part of her which is turned from us; and when she is between us and the sun, that side of her is presented to us which receives none of his rays. We thus infer, that an inhabitant of the moon has only one night and one day for each synodical revolution, each being about fifteen times 24 hours; and that inhabitant, if dwelling in the hemisphere which is unknown to us, will never see the earth.

The revolution of the moon about the earth, which occupies one focus of its ellipse, is either sidereal, or periodic, or synodic. By the first, is meant the return of the moon to the same star; and its duration is 27d. 7h. 43′ 11″. The periodic revolution has reference to the equinoxes. Its duration must be a little less than the preceding, on account of the retrograde motion of the equinoctial points—in fact, about seven seconds less. The synodic revolution, that is the return of the moon, looked at from the earth to the sun, is 29d. 12h. 44′ 2″. This revolution is longer than the preceding, because, whilst the moon advances from west to east, the earth moves also in the same direction; so that when the moon has returned to that point of her orbit whence she set out, she has still a short distance to travel before she is seen to be again in conjunction with the sun.

The moon, moving in an ellipse, does not always keep the same distance from the earth, and her apparent diameter undergoes a sensible change. It has been calculated, that her mean distance from the centre of the earth is 60,296 times the length of the terrestrial radius. After a new moon, we may distinctly see that the crescent forming the most luminous part of it is accompanied by a feeble light, spread over the rest of the disk, and which will sometimes enable us to see the whole hemisphere. This phenomenon is owing to the repercussion of the light of the sun from the earth upon the moon.

The light of the moon is not accompanied with heat. Even when the rays were collected by large reflectors, the most delicate thermometers placed in the focus were not in the least moved. The disk of the moon only occupying a 90,000th part of the heaven, the light which she gives us, being reflected from the sun, is 90,000 times less strong than his.

No atmosphere has yet been detected about the moon; and we may infer that there is no liquid upon its surface, for it can be demonstrated, that if the weight of the terrestrial atmosphere were removed, all the liquids on the earth's surface would be reduced to the state of vapour, and, ascending, would form a new atmosphere. If, then, an atmosphere is wanting, we may conclude that there are no living beings upon the moon—beings, at least, which carry on life by means of respiration.

An examination of the moon by a telescope, reveals to us that its circumference is covered with inequalities of great height, and that there are luminous points upon it. That these are sometimes visible when the sun is not throwing light upon them, is a proof that they are self-lustrous. Some have conjectured that they are volcanoes, with intermissions like Vesuvius and Ætna, and that the aerolites, or atmospheric stones, have been projected from them. It would only require a force three times greater than that which sends a ball from the mouth of a cannon, to bring a body from the moon into the sphere of the earth's attraction.

The Tides.—As the attraction of the moon is the principal cause of the tides, we think it proper to refer to them in this place. There are three phenomena relative to the tides, which are very remarkable. The first happens twice a day, the second twice a month, and the third twice a year.

Every day, some time after the passage of the moon over the meridian, we see the waters of the ocean raising themselves for six hours, and invading their banks to a height more or less considerable. They remain for a short time stationary, and then gradually fall back during six hours, to rise again when the moon crosses the meridian on the other side of the globe. In this manner high water and low water succeed one another twice a day, with a retardation of 24 minutes each time, to accord with the times of the moon crossing the meridian. The second phenomenon is, that the tides are sensibly augmented at the periods of the new and the full moons, and the increase is most apparent when the moon is in perigee. Finally, the third phenomenon is the greater elevation of the tides at the two equinoxes, and particularly at a syzygy perigee; that is, when the sun, the earth, and the moon, are in such a situation, that they are upon one line, and as near one another as possible.

From this it appears, that it is not the moon alone which exercises an influence on the waters of the earth, but that the sun has something to do with the matter. That body, by its attractive power, causes them to rise and fall, so that the solar ebbs and flows are renewed at intervals of half a solar day; those produced by the moon, at intervals of half a lunar day. These two partial tides combine, without destroying one another. When the two tides coincide, the water reaches its maximum; it is in fact the sum of two partial tides, and it takes place about the full and new moons, and near the syzygies. When the greatest height of the lunar tide coincides with the lowest ebb of the solar tide, the resulting tide is at its minimum; it is then the difference of two partial tides, and it occurs towards the quadratures, that is, when the sun and the moon are apart about 90°. At the syzygies, the attractions of the sun and moon are combined; at the quadratures, they oppose each other.

We see, then, that the tide varies with the phases of the moon; but it is not at the exact times of the new or the full moon, and of the quadratures, that the highest and lowest tides occur. Observation has discovered, that in our ports these take place a day and a half afterwards. The highest tides about the new and full moons are not equal; there are differences between them, which depend on the distances of the sun and the moon from the earth, and on their declinations. The principle of universal gravity, aided by observation, proves to us—1st, that each partial tide increases, as the cube of the apparent diameter, or of the parallax of the body which causes it; 2d, that it is diminished, as the square of the cosine of the declination of that body; and, 3d, that at the times of the mean distances of the sun and the moon from the earth, the lunar tide is three times greater than the solar tide.

That which appears difficult to comprehend, when we reflect on the motion of the tide, is the *double* ebb and flow which take place every twenty-four hours. If we assume that the moon's passing our meridian causes the rise of the water with us, how comes it that, twelve hours later, when passing the meridian on the other side of the globe, and raising the ocean there, it can produce a similar effect with us on this side? By the help of Newton's theory we will explain this. We know that the laws of gravity are universal. If the moon always obeys the attraction of the earth, which retains her in her orbit, she, on the other hand, exercises upon the earth an influence, less considerable it is true, but

which is powerful enough to displace those parts of the terrestrial ocean which are nearest her. In this position they are *more* attracted by her than the centre of the earth is, and the mobility of the aqueous particles permits them to yield somewhat to her influence; whilst the waters on the opposite side, being *less* attracted than the centre of the globe, necessarily remain behind, and appear to rise, whilst at the places where the moon is seen at the horizon, or at the distance of 90° from the meridian, the waters are low, because those which are elevated at the zenith and the nadir can only be so at the expense of those occupying an intermediate position. We may therefore consider the tides as two liquid mountains, standing upon opposite points of the earth, following the moon in her course, and traversing the surface of the ocean, during the time (increased by 48 minutes) of the rotation of the earth on its axis.

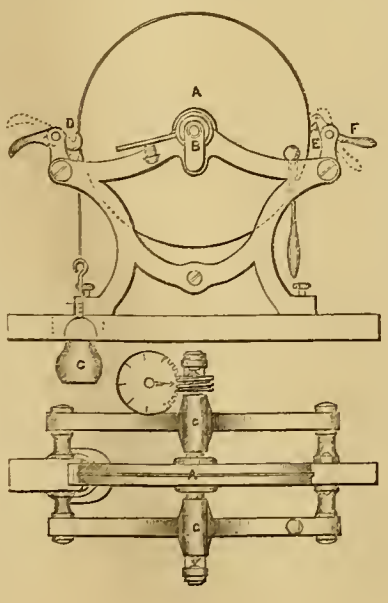
We have observed, that the elevation of the tide is several hours behind the passage of the moon across the meridian, and that it takes more time to ebb than to flow. Some general considerations will explain this. The fact is, that the two liquid mountains which the moon throws up on opposite sides of the globe, have not their axes in a line with the radius vector of the moon's elliptical orbit; and thus the passage of the moon across the meridian cannot occur at the precise moment when the phenomenon takes place. Moreover, the friction of the water on its bed and at its sides, the cohesion of its particles, and the rotation of the earth, are causes which prevent its rise being instantaneous.

The phenomena of the tides, the solution of which excited the despair of ancient observers, are now seen to follow from the great laws which set the universe in motion. At the present day, we prepare tables which indicate beforehand the instant of the return of the tide to a given port; and we can even ascertain the exact height to which the water will rise, if the influence of the sun and moon should not be disturbed by temporary causes.

THOMAS'S OIL-TEST.

The earliest mechanical contrivance for accurately ascertaining the lubricating qualities of different oils, was that of the revolving discs, invented by the late Mr. John M'Naught of this city. In this apparatus two plane metal discs are set, with their faces just out of contact; the lower one being driven by a cord-pulley on its spindle. A film of the oil to be tested, is interposed between the two surfaces, and as the upper disc is carried round by reason of the tenacity of the oil upon the lower revolving one, it presses, by means of a pin, upon the end of a lever in connection with a steel-yard lever carrying an adjustable weight. The tenacity of the oil, or, in other words, the friction generated by its action upon the two surfaces, is thus indicated and measured by the weight which the pressure of the pin of the upper disc will raise on the steel-yard.

The contrivance we now describe, acts on a different principle. It is the invention of Mr. Thomas of Manchester. Fig. 1 is a front elevation, and fig. 2 a plan corresponding, on a scale of 1-4th of the original size of the machine. A, Is a brass disc fast upon a steel spindle, B, which is nicely balanced upon pointed centres. A weight, C, is hung by a fine silk cord to the periphery of the disc, by a pin which takes into the receiving catch, D, when the catch falls into the position shown by the dotted lines. By holding the catch down as drawn, and turning the disc in the contrary direction, the projection, E, will lift the pin with the cord attached, as held by the catch, F; then, by releasing the holding catch, the weight runs down, and gives motion to the disc, which will revolve for a longer or shorter period, according to the quality of the oil used in lubricating the bearings of the shaft, G G. A worm on the shaft indicates the exact number of revolutions made, by the small index wheel, into which it gears. Of course the greater number of revolutions made by the disc, when acted upon by the falling weight, the purer and more valuable is the lubricator, as less momentum is then expended in overcoming the friction of the bearing surfaces. And herein is the difference between the two arrangements—for whilst, in the latter case, a single impulse of the weight gives a greater or less number of revolutions of the disc, so, in the former, a continued and regular rate of movement of the lower disc holds in suspension a greater or less weight, according to the lubricating power of the oil. In Mr. M'Naught's test, if good sperm oil indicates 30 on the scale, then neat-foot, olive, or gallipoli, will be about 60. Both apparatuses are ingenious, and will accurately register the quality of the oil, if correctly made and adjusted.



1-4th.

ON THE STRENGTH OF MATERIALS, AS INFLUENCED BY THE EXISTENCE OR NONEXISTENCE OF CERTAIN MUTUAL STRAINS AMONG THE PARTICLES COMPOSING THEM.*

By James Thomson, Jun., M.A., College, Glasgow.

My principal object in the following paper is to show, that the absolute strength of any material composed of a substance possessing ductility (and few substances, if any, are entirely devoid of this property), may vary, to a great extent, according to the state of tension or relaxation in which the particles have been made to exist when the material as a whole is subject to no external strain.

Let, for instance, a cylindrical bar of malleable iron, or a piece of iron wire, be made red hot, and then be allowed to cool. Its particles may now be regarded as being all completely relaxed. Let, next, the one end of the bar be fixed, and the other be made to revolve by torsion, till the particles at the circumference of the bar are strained to the utmost extent of which they can admit, without undergoing a permanent alteration in their mutual connexion.† In this condition, equal elements of the cross section of the bar afford resistances proportional to the distances of the elements from the centre of the bar; since the particles are displaced from their positions of relaxation through spaces which are proportional to the distances of the particles from the centre. The couple which the bar now resists, and which is equal to the sum of the couples due to the resistances of all the elements of the section, is that which is commonly assumed as the measure of the strength of the bar. For future reference, this couple may be denoted by L, and the angle through which it has twisted the loose end of the bar by Θ.

The twisting of the bar, may, however, be carried still farther, and during the progress of this process the outer particles will yield in virtue of their ductility, those towards the interior assuming successively the condition of greatest tension; until, when the twisting has been sufficiently continued, all the particles in the section, except those quite close to the centre, will have been brought to afford their utmost resistance. Hence, if we suppose that no change in the hardness of the substance composing the material has resulted from the sliding of its particles past one another; and that, therefore, all small elements of the section of the bar afford the same resistance, no matter what their distances from the centre may be, it is easy to prove that the total resistance of the bar is now $\frac{4}{3}$ of what it was in the former case; or, according to the notation already adopted, it is $\frac{4}{3}L$.‡

* From the *Cambridge and Dublin Mathematical Journal*.

† I here assume the existence of a definite "*elastic limit*," or a limit within which, if two particles of a substance be displaced, they will return to their original relative positions when the disturbing force is removed. The opposite conclusion, to which Mr. Hodgkinson seems to have been led by some interesting experimental results, will be considered at a more advanced part of this paper.

‡ To prove this, let r be the radius of the bar, η the utmost force of a unit of area of the section to resist a strain tending to make the particles slide past one another; or to resist a shearing strain, as it is commonly called. Also, let the section of the bar be supposed to be divided into an infinite number of concentric annular elements; the radius of any one of these being denoted by x, and its area by $2\pi x dx$.

Now, when only the particles at the circumference are strained to the utmost; and when, therefore, the forces on equal areas of the various elements are proportional to the distances or the elements from the centre, we have $\eta \frac{x}{r}$ for the force of a unit of area at the distance x from the centre. Hence the total tangential force of the element is

$$= 2\pi x dx . \eta \frac{x}{r},$$

and the couple due to the same element is

$$= x . 2\pi x dx . \eta \frac{x}{r} = 2\pi\eta \frac{1}{r} . x^3 dx:$$

and therefore the total couple, which has been denoted above by L, is

$$= 2\pi\eta \frac{1}{r} \int_0^r x^3 dx,$$

that is $$L = \tfrac{1}{2}\pi\eta r^3 \quad \ldots\ldots (a).$$

Next, when the bar has been twisted so much that all the particles in its section afford

If, after this, all external strain be removed from the bar, it will assume a position of equilibrium, in which the outer particles will be strained in the direction opposite to that in which it was twisted, and the inner ones in the same direction as that of the twisting, the two sets of opposite couples thus produced among the particles of the bar balancing one another. It is easy to show that the line of separation between the particles strained in the one direction, and those in the other, is a circle whose radius is $\frac{3}{4}$ of the radius of the bar. The particles in this line are evidently subject to no strain * when no external couple is applied. The bar with its new molecular arrangement may now be subjected, *as often as we please*,† to the couple $\frac{4}{3}L$, without undergoing any farther alteration; and therefore its ultimate strength to resist torsion, in the *direction of the couple L*, has been considerably increased. Its strength to resist torsion in the opposite direction has, however, by the same process, been much diminished; for, as soon as its free extremity has been made to revolve backwards through an angle of $\frac{2}{3}\ \Theta$ from the position of equilibrium, the particles at the circumference will have suffered the utmost displacement of which they can admit without undergoing permanent alteration. Now it is easy to prove that the couple required to produce a certain angle of torsion is the same in the new state of the bar as in the old.‡ Hence the ultimate strength of the bar when twisted backwards, is represented by a couple amounting to only $\frac{2}{3}L$. But, as we have seen, it is $\frac{4}{3}L$ when the wire is twisted forwards. That is, then, *the wire in its new state has twice as much strength to resist torsion in the one direction as it has to resist it in the other.*

Principles quite similar to the foregoing, operate in regard to beams subjected to cross strain. As, however, my chief object at present is to point out the existence of such principles to indicate the mode in which they are to be applied, and to show their great practical importance in the determination of the strength of materials, I need not enter fully into their application in the case of cross strain. The investigation in this case closely resembles that in the case of torsion, but is more complicated on account of the different ultimate resistances afforded by any material to tension and to compression, and on account of the numerous varieties in the form of section of beams which for different purposes it is found advisable to adopt. I shall therefore merely make a few remarks on this subject.

If a bent bar of wrought-iron, or other ductile material, be straightened, its particles will thus be put into such a state, that its strength to resist cross strain, in the direction towards which it has been straightened, will be very much greater than its strength to resist it in the opposite direction, each of these two resistances being entirely different from that which the same bar would afford, were its particles all relaxed when the entire bar is free from external strain. The actual ratios of these various resistances depend on the comparative ultimate resistances afforded by the substance to compression and extension; and also, in a very material degree, on the form of the section of the bar. I may however state, that in general the variations in the strength of a bar to resist cross strain, which are occasioned by variations in its molecular arrangement, are much greater even than those which have already been pointed out as occurring in the strength of bars subjected to torsion.

What has been already stated is quite sufficient to account for many very discordant and perplexing results which have been arrived at by different experimenters on the strength of materials. It scarcely ever occurs that a material is presented to us, either for experiment or for application to a practical use, in which the particles are free from great mutual strains. Processes have already been pointed out by which we may at pleasure produce certain peculiar strains of this kind. These or other processes producing somewhat similar strains, are used in the manufacture of almost all materials. Thus, for instance, when malleable iron has received its final conformation by the process termed *cold swaging*, that is, by hammering it till it is cold, the outer particles exist in a state of extreme compression, and the internal ones in a state of extreme tension. The same seems to be the case in cast-iron, when it is taken from the mould in which it has been cast. The outer portions have cooled first, and have therefore contracted while the inner ones still continued expanded by heat. The inner ones then contract as they subsequently cool, and thus they, as it were, pull the outer ones together. That is, in the end, the outer ones are in a state of compression, and the inner ones in the opposite condition.

The foregoing principles may serve to explain the true cause of an important fact observed by Mr. Eaton Hodgkinson, in his valuable researches in regard to the strength of cast-iron. (*Report of the British Association for* 1837, p. 362.)§ He found that, contrary to what had been previously supposed, a strain, however small in comparison to that which would occasion rupture, was sufficient to produce a set in the beams on which he experimented. Now this is just what should be expected in accordance with the principles which I have brought forward; for if, from some of the causes already pointed out, various parts of a beam, previously to the application of an external force, have been strained to the utmost—when, by the application of such force, however small, they are still farther displaced from their positions of relaxation—they must necessarily undergo a permanent alteration in their connection with one another, an alteration permitted by the ductility of the material; or, in other words, the beam as a whole must take a set.

In accordance with this explanation of the fact observed by Mr. Hodgkinson, I do not think we are to conclude with him that "the maxim of loading bodies within the elastic limit has no foundation in nature." It appears to me that the defect of elasticity, which he has shown to occur even with very slight strains, exists only when the strain is applied for the first time; or, in other words, that if a beam has already been acted on by a considerable strain, it may again be subjected to any smaller strain in the same direction without its taking a set. It will readily be seen, however, from Mr. Hodgkinson's experiments, that the term "elastic limit," as commonly employed, is entirely vague, and must tend to lead to erroneous results.

The considerations adduced seem to me to show clearly, that there really exist *two elastic limits* for any material, between which the displacements or deflexions, or what may in general be termed the changes of form, must be confined, if we wish to avoid giving the material a set; or, in the case of variable strains, if we wish to avoid giving it a continuous succession of sets, which would gradually bring about its destruction: that these two elastic limits are usually situated one on the one side, and the other on the opposite side, of the position which the material assumes when subject to no external strain, though they may be both on the same side of this position of relaxation,‖ and that they may therefore, with propriety, be called the *superior* and the *inferior limit* of the change of form of the material for the particular arrangement which has been given to its particles: that these two limits are not *fixed* for any given material; but that, if the change of form be continued beyond either limit, two new limits will, by means of an alteration in the arrangement of the particles of the material, be given to it in place of those which it previously possessed: and lastly, that the processes employed in the manufacture of materials are usually such as to place the two limits in close contiguity with one another, thus causing the material to take, in the first instance, a set from any strain however slight, while the interval which may afterwards exist between the two limits, and also as was before stated, the actual position assumed by each of them, is deter-

---

their utmost resistance, we have the total tangential force of the element $= 2\pi x dx.\eta$, and the couple due to the same element

$$= x.2\pi x dx.\eta = 2\pi\eta x^2 dx.$$

Hence the total couple due to the entire section is

$$= 2\pi\eta \int_0^r x^2 dx = \tfrac{2}{3}\pi\eta r^3.$$

But this quantity is $\frac{4}{3}$ of the value of L in formula (a). That is, the couple which the bar resists in this case is $\frac{4}{3}L$, or $\frac{4}{9}$ of that which it resisted in the former case.

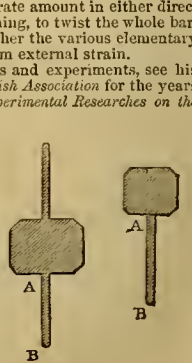
* Or at least they are subject to *no strain of torsion* either in the one direction or in the other; though they may perhaps be subject to a strain of compression or extension in the direction of the length of the bar. This, however, does not fall to be considered in the present investigation.

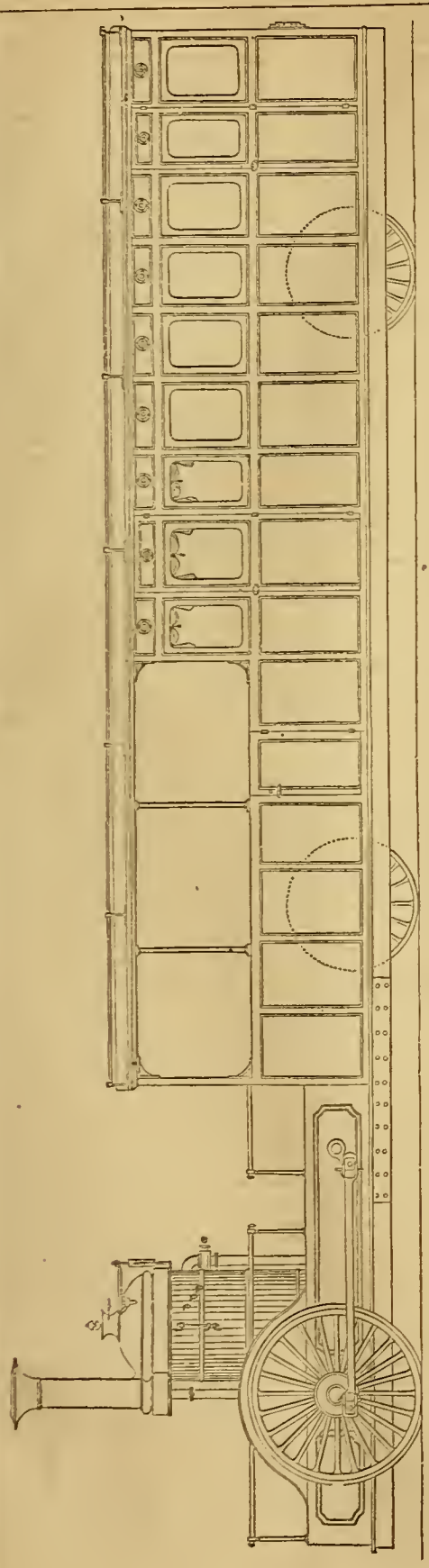
† This statement, if not strictly, is at least extremely nearly true: since, from the experiments made by Mr. Fairbairn and Mr. Hodgkinson on cast-iron (see various *Reports of the British Association*), we may conclude that the metals are influenced only in an extremely slight degree by time. Were the bars composed of some substance, such as sealing-wax or hard pitch, possessing a sensible amount of viscidity, the statement in the text would not hold good.

‡ To prove this, let the bar be supposed to be divided into an infinite number of elementary concentric tubes (like the so-called annual rings of growth in trees). To twist each of these tubes through a certain angle, the same couple will be required whether the tube is already subject to the action of a couple of any moderate amount in either direction, or not. Hence, to twist them all, or, what is the same thing, to twist the whole bar, through a certain angle, the same couple will be required whether the various elementary tubes be or be not relaxed, when the bar as a whole is free from external strain.

§ For farther information regarding Mr. Hodgkinson's views and experiments, see his communications in the *Transactions of the Sections of the British Association* for the years 1843 (p. 23) and 1844 (p. 25), and a work by him, entitled *Experimental Researches on the Strength and other Properties of Cast Iron.* 8vo. 1846.

‖ Thus, if the section of a beam be of some such form as that shown in either of the accompanying figures, the one rib or the two ribs, as the case may be, being very weak in comparison to the thick part of the beam, it may readily occur that the two elastic limits of deflexion may be situated both on the same side of the position assumed by the beam when free from external force. For if the beam has been supported at its extremities, and loaded at its middle, till the rib $A\,B$ has yielded by its ductility so as to make all its particles exert their utmost tension, and if the load be now gradually removed, the particles at B may come to be compressed to the utmost before the load has been entirely removed.





mined by the peculiar strains which are subsequently applied to the material. The introduction of new, though necessary, elements into the consideration of the strength of materials may, on the one hand, seem annoying, from rendering the investigations more complicated. On the other hand, their introduction will really have the effect of obviating difficulties, by removing erroneous modes of viewing the subject, and preventing contradictory or incongruous results from being obtained by theory and experiment. In all investigations, in fact, in which we desire to attain, or to approach nearly, to truth, we must take facts as they actually are, not as we might be tempted to wish them to be, for enabling us to dispense with examining processes which are somewhat concealed and intricate, but are not the less influential from their hidden character.

ADAMS' COMPOSITE LOCOMOTIVE CARRIAGE.

The carriage-engine system of Mr. Adams, which we were the first to introduce to public notice, in our large engraving of the "Enfield,"* now running on the Enfield and Edmonton branch of the Eastern Counties line, has gradually made an impression upon the minds of all interested parties, and its results have fully confirmed all that we then advanced. The "Enfield," in working order, weighs something under 15½ tons, thus distributed:—Leading wheels, 4 tons 12 cwt.; driving wheels, 6 tons 1 cwt. and 3 qrs.; trailing wheels, 4 tons 15 cwt. In her late trial on the Eastern Counties line, she had an additional trailing carriage, capable of carrying forty-eight passengers, and weighing 3½ tons. Her greatest speed, under these circumstances, was at the rate of eight miles in nine minutes, on a level part of the Yarmouth line, the working steam pressure being 100 lbs. The journey from Norwich to London (126 miles) was made in 5 h. 7 min., from which is to be deducted the time lost in the seven stoppages, being an aggregate of 1 h. 41 min.; leaving 3 h. 36 min. as the net time of running. This comes to 24.6 miles per hour, including stoppages, or 36.7 miles per hour for the actual running time.

The coke consumed, including the amount used in getting up the steam from cold water, was 12 cwt. 16 lbs., or 10.79 lbs. per mile. The quantity actually consumed in taking the load was 11 cwt. 2 qrs., or at the rate of 10.22 lbs. per mile. The total number of miles run between the hours of 11.45 A.M. and 10.7 P.M. was 197; the coke burned in such time, including getting up the steam, being 19 cwt., or 10.29 lbs. per mile; or, for the whole period, 205 lbs. per hour, including stoppages.

On another occasion, Mr. Samuel, to whom we are indebted for these particulars, made a trip from Enfield to London (12¾ miles), calling at Lower Edmonton, Lea Bridge, and Stratford, in 29 minutes, the stoppages taking up 9 minutes; leaving 20 minutes for the running time. Owing to the occurrence of the several junctions in the route, the speed was reduced at each to 5 miles per hour; but she maintains a regular speed of 40 miles per hour, with the trailing carriages fully loaded, or with a gross paying load of 74 passengers, consuming 10.22 lbs. per mile.

In continuing our illustrations of the system, we have introduced the engraving of a new composite carriage-engine, which accompanies this article. It differs in many respects from the "Enfield," having a vertical boiler, and cylinders detached from the driving-axle, as well as a differently-arranged passenger department. The cylinders are 8 inches diameter, and 12 inches stroke, similar to the "Fairfield," mentioned at page 194, *ante*. The driving wheels, which are also the leaders, are 4 feet 6 inches diameter, and the middle and trailing ones are 3 feet. The wheels run loose on their axles, as also the axles in their journals, so as to afford the greatest facility in passing round curves. Extreme centres of wheels, 29 feet; weight in working order, 12 tons. The carriage, which is so fitted to the engine by side-plates bolted on, as to be removeable therefrom at pleasure, is built to carry 62 passengers—10 first-class, in the centre compartment; 24 second, in the third; and 28 third, in the first.

The general arrangement of the engine is similar to that of the "Fairfield," to which we have before referred, the pistons being connected to a detached crank-shaft below the footplate, and which shaft has two outside cranks, with connecting-rods passing to pins in the driving wheels.

By keeping down the centre of gravity, bringing the frame so low as 9 inches from the rail, great steadiness is preserved, whilst the chance of leaving the rails is almost annihilated. The consumption of coke is found to be from 8 to 10 lbs. per mile, in the regular working of the traffic.

The vertical boiler offers some advantages in point of arrangement and adaptation to a small space; but, in as far as efficiency and economy are concerned, we should say the horizontal one will supersede it, except, perhaps, for engines of the very smallest class.

MENNIE'S FEATHERING PADDLE-WHEEL.

Mr. Mennie, of Castle Street, Forfar, has submitted to us a model of an ingenious feathering-paddle, which appears to answer its end with very simple mechanism. The feathering movement is obtained from two fixed circular discs, set one on each side of the outer paddle-arms, eccentric to the axis of the paddle. From the arrangement of the model, we presume that the inner eccentric disc is to be carried by the ship's side, whilst the outer one will be upon the outer framing of the paddle-box. The lines of eccentricity of the two discs are at right angles to one another, and each has a ring working on its periphery, with connecting-rods, or links, passing to crank-pins on spindles, which are attached to the floats, and have their bearings in the paddle-rings. Each float has two cranks, one on each end, set at right angles; and as the paddle revolves, the action of the two rings on the eccentric discs

* Page 193, Practical Mechanic's Journal.

is such, as to preserve each float in a perfectly vertical line in entering and leaving the water. Mr. Mennie is of opinion, that one eccentric disc, with connecting-liuks working ono series of cranks, will be found sufficient in practice, as the floats may be so balanced on their spindles, as to be assisted in their vertical action hy the pressure of the water.

The model we have before us, works with all the precision that can he desired; but, of course, something is added to the weight, complication, and cost of the paddle.

THE MECHANIC'S LIBRARY.

Agriculture of Suffolk, 8vo. 10s. 6d. cloth. W. & H. Raynbird.
Algebraic Equations, Theory of, 8vo. 6s. cloth. Rev. W. Thynne.
Arithmetic, Key to, 12mo. 2s. clotb. Kavanagh.
Chemistry, Text-Book of Inorganic, 12mo. 5s. 6d. cloth. D. Campbell.
Churches, Parish, royal 8vo. £2 2s. clotb. R. & J. A. Brandon.
Cosmos, "Bohn's Scientific Library," 2 vols. 7s. cloth. Humboldt.
Cottage Architecture, plates, folio, 25s. cloth. Weaver.
Drawing and Mensuration, Lineal, second edition, 12mo. 2s. 6d. cloth. Pickton.
Engineers, Papers of the Royal, Vol. X. 4to. 30s. cloth.
Gold-Seeker's Manual, foolscap 8vo. 3s. 6d. cloth. Professor Ansted.
Hydraulic and other Machines, second edition, royal 8vo. 18s. T. Ewbank.
Locomotive Engine, Student's Guide to the, plates, 8vo. 21s. clotb.
Meteorology, "Chambers' Educational Course," 12mo. 10d. clotb.
Railway Economy, 8vo. 1s. 6d. sewed. L. Gordon.
Scientific Knowledge, Guide to, new edition, 18mo. 3s. 6d. clotb. Dr. Brener.
Ship-Master's Assistant, royal 8vo. 30s. sheep. J. Blunt.
Year-Book of Facts for 1849, foolscap 8vo. 5s. cloth.

RECENT PATENTS.

FLAX AND TOW.—John Martin, County Down, Ireland, Manufacturer.—*Enrolled Jan.* 6, 1849.

Claims—"The arrangement of apparatus for sharpening the teeth of cards in carding engines, and for removing tbe dirt from between them; the arrangement of heckle stacks in cocks moved outwards by strikers; the combination of receivers for causing the traversing to he made correctly; the arrangement of an apparatus for governing the descent of the flax, whereby the holders may be caused to move at a different speed, and the speed of each holder varied; the application of steam in the preparation of fihrous materials, and the arrangement of apparatus for varying tbe drag upon tho bobbins."

TOBACCO-PIPES.—E. Steel and W. Britter, Lambeth, Manufacturers.—*Enrolled Jan.* 6, 1849.

Claims—"The apparatus constituted by the arrangement and combination of mechanical parts described, in reference to the manufacture of tobacco-pipes, and to the compressing of the clay or other material in a mould or moulds to form the howls, and expelling the surplus through an opening to form the stem, whereby the howl and stem are made at tho same time."

STOVES, GRATES, AND FURNACES.—W. Newton, London. *Enrolled Jan.* 6, 1849.—(*Communication.*)

Patentee claims—Tbe combination of the chamber of combustion, in which any kiud of fuel is burned, with a drum or chamber of combustion, in which the products evolved from the combustion of the fuel are rendered inflamed and inflaming hy means of a "throat." The making tbe top aperture of the throat smaller than the bottom one, and than the opening of the fire-pot, in order that the products evolved may commingle with the air hefore they pass into the drum. Tbe making a portion of the throat of larger diameter than either tbe top or bottom aperture, where the air is introduced into or among the products of combustion. Introducing jets of air among the products of combustion, whereby they are rendered inflamed and inflaming.

ELECTRIC LIGHT.—W. E. Staite, London.—*Enrolled Jan.* 8, 1849.

The description of the various details is of very great length, and this, together with the lateness of its appearance, prevents our giving much more than the heads of the invention, which are:—1. The making of electric batteries upon what is called the "perfluent principle,"—the exciting fluid being passed successively through each cell, and being finally discharged from the last into a receiver. This is effected by so making the trough, that the liquid is not permitted to enter the second cell until it has gone through the first; or by applying a set of syphons for this purpose. Patentee remarks, that the electric action is greatest at the central cell, gradually diminishing in the succeeding ones; but that the ratio of decrease is not equal throughout, the last cell heing very considerahly more diminished in intensity; and, in order to equalize it, the wires from several cells should be combined at the last one. 2. An improved mode of regulating the supply and discharge of liquids employed in galvanic batteries. 3. The construction of a meter, for supplying the battery with the fluids used, so that a large quantity may be put into it, and, by means of the peculiar arrangements thereof, passed through the cells with equability at the rapidity required. 4. The use, in batteries having either copper or mercury for the negative element, of a liquid amalgam compound of zinc and of mercury, enclosed in a hag or case of lawn, horse-hair cloth, or other reticulated fabric, provided it he not a metallic fabric, and exposed to the actiou of the acid. 5. The use in galvanic batteries of plates of a similar amalgam, composed of five parts of zinc to one of mercury. 6. The employment in batteries of lead as the positive element, combined with any known negative element; though it is remarked, that the hest negative element would be a surface of platinum. 7. The constnction of a galvanometer, or instrument for testing, with precision, the amount or intensity of the electric action—an instrument of much use in ascertaining the speed at which the solution should be allowed to pass through the cells of the battery. 8. The invention consists in the formation of magnets in the manner following: The best Swedish charcoal iron is to be "converted," not in the ordinary manner, but only by a slight carbonization, or what is technically termed carbonizing it "just steel through." The hlistered product is then melted and cast, and the ingot resulting from the process is rolled out into thick sheet metal. 9 The invention consists in the following improved mode of hardening magnets, previous to magnetising them: Instead of heating them, as usual, in an ordinary furnace or sand-bath, they are heated in a bath of melted metal, raised to a red heat (using hy preference lead), first polishing the magnets, in order to prevent the lead or its oxide from adhering to their surfaces, the heat of the lead being only just sufficient to barden the magnets; on takiug them out of the bath, they are afterwards plunged into water. 10. Various improvements upon the mechanism and arrangements of the apparatus for producing electric light, amongst which is an improvement, wherehy the construction and action of the upper charcoal point, or electrode, is caused to revolve against a scraper, which removes the charcoal deposits, invariahly passing from the lower piece of charcoal, and attaching themselves to the upper. Another improvement in the lamp consists in substituting for the upper electrodes previously employed, a disc, or circular electrode, fixed on an axis, which disc has a slow motion imparted to it in any given direction by the moving power employed in the lamp. Impinging on the periphery of this disc, there is a metal scraper, which keeps the edge of the disc clean, and free from the particles of carbon which are projected upon it by the other electrode, and which ordinarily collects, in the shape of a button, on the point of the electrode. A further improvement consists in the employment of iridium as an electrode, which is suitable for smaller lights—iridium being, of all known metals, the hardest and most intractahle, and bearing an excessive degree of heat without fusing. 11. Tbe iuvention consists of certain arrangements for producing a regularly intermittent light from electricity, especially suitable for lighthouses, and may be applied to other purposes. 12. The invention consists in improving the intensity of the electric current, whatever may be the nature of the lamp, or apparatus, used for producing the light: this is effected hy including in the electric circuit a long coil of insulated copper ribhon, wound in an iron case, whereby it will be easy, at the same time, to reduce the numher of cells employed. 13. The invention consists iu enclosing the solid electrodes, employed in electric lamps, in supporting tubes. 14. The invention consists in improved modes of preparing the materials for electrodes. Lastly: The invention consists in the employment of galvanic batteries for the purpose of ohtaining various chemical products, and this either in conjunction with the employment of them for lighting and motive purposes, or as substitutes for tbe ordiuary processes of chemical manufacture. The batteries should be of one or other of the perfluent sorts, herein hefore described, on account of the facilities which they afford for drawing off the products of the galvanic action, which products may consist either of matters in a marketahle state, or which require some additional treatment to make them of commercial value. The elements proper to be employed will vary in each case with the chemical prodnct or products desired to he ohtained; or, to state the matter conversely, the perfluent products will vary with the elements employed. For example, where zinc is used as the positive metal with sulphuric acid, sulphate of zinc is formed; hut sulphate of zinc in large quantities would not be of great commercial value. When, therefore, I use zinc as aforesaid, I collect the sulphate of zinc, and treat it as follows:—I add, in a separate vessel, to the solution of sulphate of zinc, a solution of sesqui-carhonate of ammonia, which precipitates the oxide of the zinc metal, aud releases tbe acid,

which may be used again. This oxide of zinc is a valuable substitute for carbonate of lead as a pigment, and may be used extensively for painting purposes. Again, suppose any of the salts of lead are required to be produced, such as nitrate of lead (white lead), or sulphate of lead, or any other chemical substance, to the production of which these salts may be auxiliary, the battery should be constructed of lead, or other metal plates, platinized and excited to action by dilute nitric acid. The acid acting on the oxide of lead, formed by the electrolytic process, or decomposition of water, dissolves it, and forms with it a solution of the nitrate of lead; and this solution is afterwards treated in a separate vessel, or vessels, with the carbonate, or bicarbonate of potash, when a double decomposition takes place; and, the carbonate of lead being precipitated, the matter of commerce remains in solution, and is obtained by evaporation. Supposing, further, the platinized plates of lead, or other metal, are used with muriatic acid, dilute or not, then the acid is decomposed, and a solution of chloride of lead is the resulting product. If, for the platinized plates, we substitute iron or zinc plates, the chloride of iron or of zinc is respectively obtained. Should a battery of copper and of iron plates, charged with a solution of sulphate of copper, be employed, the iron is oxidized, the sulphuric acid unites with the oxide by superior affinity, and forms with it sulphate of iron (the green copperas of commerce), which remains in solution, and may be obtained by evaporation as before. The hydrogen, which is released, goes to the other plate—that is, to the copper plate; and, meeting there the disengaged oxide of copper, reduces it to the metallic state, and, in fact, plates the copper with it. This form of battery is directly applicable to the production of metallic copper from the ores of the sulphuret, decomposed by water, or from the water drawn from certain copper mines, which contain sulphate of copper in solution; the sulphate of iron obtained forms also a very fine ochre.

GUTTA PERCHA AND CAOUTCHOUC.—A. Lorimer, London, Bookbinder.—*Enrolled Jan.* 10, 1849.

Claims—"The means of cleansing gutta percha preparatory to its being componnded with other materials. The compound of gutta percha. The compound of caontchouc."

SOAP.—L. Castelain, London, Chemist.—*Enrolled Jan.* 11, 1849.

Patentee mixes gum carragan, or Irish moss, with soap. He dissolves 112 parts of the material in 472 gallons of hot water mixed with salt, in the proportion of four ounces to a gallon of the solution. The soap is run into "frames," and added to the mixture in the proportion of five to one. Claim—"The employment of gum carragan or Irish moss, or other moss of like nature, in the manufacture of soap."

RAILWAY WHEELS.—M. Kirtley, Derby, Engineer. *Enrolled Jan.* 11, 1849.

Claim—"Forming bars of iron, by rolling, with angular ends, suitable for the spokes of railway wheels."

DIBBLING AND PROPELLING VESSELS.—J. Ross, Leicester, Agent.—*Enrolled Jan.* 11, 1849.

Claims are—"1. The combination and arrangement of mechanical parts in a dibbling and sowing apparatus, whereby both operations are effected at the same time. 2. The arrangement and combination of several of these apparatuses in a frame, to be drawn by horses, and in connection with cranks and toothed gearing, so that they are alternately plunged into the ground where they deposit the seed, and lifted out, the earth being filled in afterwards by any suitable means. 3. The application of the preceding mechanical arrangement, for raising and lowering the dibbling apparatuses, to the propulsion of vessels, by causing a series of vertical paddles, placed on either side of the vessel at the bow and at the stern, to be thrust into the water, drawn backwards, lifted out, and brought back into their original positions. 4. Causing the paddles to feather when they are no longer acting against the water."

CLOCKS AND TELEGRAPHS.—R. Roberts, Manchester, Engineer. *Enrolled Jan.* 11, 1849.

Claims are—1. An arrangement and combination of apparatus whereby tidal power is rendered applicable in effecting the motion of clockwork and other machinery. 2. An arrangement for driving the striking and going hand from one spring or weight, and for overcoming the difficulty of the guide-pulley in turret and other clocks. 3. A mode of causing the time indicated upon the dial of one clock, to be indicated simultaneously upon a number of dials placed at a distance; and its application to purposes of telegraphic communication. 4. An arrangement for imparting equimotive impulses to time-keepers. 5. A method of causing the hand or index to move a distance corresponding to the number of oscillations of the pendulums. 6. A combination whereby pocket and box chronometers are made to beat dead seconds. 7. An arrangement for recording the duration of an occurrence without interfering with the other movements of the time-keeper. 8. Certain improvements in the compensating balances of chronometers. 9. A cycloramic dial. (The dial and hand both transparent.) 10. The employment of toothed sectors for effecting striking in clocks. 11. A chronometer with equimotive escapements, whereby its mechanism is made to act with greater accuracy. 12. A mode of hardening and manufacturing the dials of time-keepers. 13. A "normal drill." 14. A guage for ascertaining the sizes of the different parts of time-keepers.

GENERATING STEAM; AND MOTIVE POWER.—F. A. T. Beauregard, Paris, Engineer.—*Enrolled Jan.* 11, 1849.

We have described the general features of M. Beauregard's invention in a previous page,* as translated from *La Presse;* there is therefore little now to be added to that account, except as far as regards its now legal introduction into this country. The phenomena attending the spheroidal condition of water, as developed by M. Bontigny, have afforded material for the exercise of M. Beauregard's inventive faculties; but, we fear, to very little purpose. At the time of the first mention of the discovery, it was of course scouted by all our practical men; but in order to form an opinion from facts, we have delayed noticing it further, until the enrolment of the specification here put us in possession of the requisite information.

Having been favourably reported upon by a committee of the *Societé d'Encouragement*, we had reason for supposing, with the assistance of an elastic imagination, that there might be *something* in it; but we now find, from the patentee's own account, that there is absolutely nothing of value to be found in it.

Badly drawn up, badly interpreted, and full of mistaken ideas, we have given up the hope of arriving at a notion of the meaning of a great portion of it, and what we have seen is not worth relating.

ARTIFICIAL FUEL.—W. E. Hollands, and N. W. Green, London. *Enrolled Jan.* 18, 1849.

Claims—"The employment of gypsum, caustic lime, or other caustic cements, before mentioned, combined with water and small coal, with or without other materials, to produce concrete blocks or lumps of artificial fuel; and coating the surfaces of these lumps with oil."

FIXING LETTERS OF METAL ON GLASS, MARBLE, OR WOOD.—J. L. Lamenaude, London.—*Enrolled Jan.* 18, 1849.

Claims—1. The securing or fixing thin metallic letters on glass, marble, stone, porcelain, wood, metal, crystal, or any other hard and smooth surface, without the use of metallic fastenings. 2. The making thin letters of metal, and coating them with an enamel surface of any colour; also, letters made by the electro-galvanic process, or letters gilded by the electro-galvanic process, and of fixing the same by the compositions herein named. 3. The compositions, named in this specification, as applied to affixing letters on the surfaces of the within-named materials. 4. The various materials in these compositions, with the solvents, in any proportions, as applied to the purposes of affixing letters on the polished surfaces of the material herein named. We may remark, that the 3d claim is inconsistent with the title of the patent, which is for "the process of applying and fixing" only.

STEAM-ENGINES AND BOILERS.—J. Stenson, Northampton, Engineer.—*Enrolled Jan.* 18, 1848.

Claims—"1. The rotatory engine, as described in the peculiar arrangement and combination of parts of which the same consists (but without claiming any of them individually and separately); and also three several modifications thereof. 2. An improved rotatory emission engine, as described, in so far as regards the employment therein of two steam wheels, one attached to and revolving with the axis, and the other turning freely upon it; and in so far also as regards the indenting of the inner faces of the edges of the wheels. 3. An improved oscillating

* Page 200, *ante*.

engine, as described, in so far as regards the cross-head, and a frame in which it slides. 4. Several improved methods of constructing boilers represented in drawings from fig. 13 to fig. 36, both inclusive, and as described, in so far as regards the increased amount of fire and flue surfaces obtained in each case, and the peculiar arrangements by which such increase is effected. 5. A self-acting damper, as described. 6. An arrangement for heating the feed-water of condensing engine-boilers, as described. 7. An arrangement for facilitating the condensation of the exhaust steam in condensing engines, as described. 8. The employment in locomotive engines of two boilers, placed and connected, as described. 9. An arrangement whereby the steam issuing from the boilers of locomotive engines, is caused to pass through a case placed within the smoke-box, before passing to the working cylinder, as described. 10. An improvement in guage-cocks, as described. 11. A mode of strengthening steam-pipes by tension rods, as described. 12. An improved cooking apparatus, as described, in so far as regards the boiler and the parts immediately connected therewith and dependent thereon. 13. The employment of steam-engines to work from a distance threshing and other agricultural machines, through the medium of condensed air and emission wheels (or other equivalent machinery), as before described. 14. The adaptation of emission and other steam engines to the obtaining of electric light from steam, in manner described. 15. An arrangement whereby the air-pump may be dispensed with in condensing engines, or at least used of much smaller dimensions than usual, as before described."

BRICK KILNS.—W. Swain, Penbridge, Brickmaker.—*Enrolled Jan.* 18, 1849.

Patentee describes a furnace having a feed-passage in the side, with a tight-fitting door slanting downwards, and a projecting brick at the bottom to throw off the coals into the furnace. Furnace is of fire-bricks with spaces between them, and has a set of furnace-bars and ash-pit as usual. The admission of air is regulated by a door fitting tightly, and having another small door in the centre, to admit a rake.

He claims the "peculiar character" of his invention, whereby a greater influx of air than is necessary for combustion in the interior of the kiln is prevented. What the "peculiar character" is, we are at a loss to know.

APPARATUS FOR SAVING TIMBER-LOADED VESSELS, WHEN IN DANGER OF FOUNDERING.—C. Purnell, Liverpool, Clockmaker.—*Enrolled Jan.* 18, 1849.

Patentee applies cisterns of from 50 to 100 gallons content, fitted to the inside of the vessel fore and aft. They are open at the top, and closed at the bottom, by a self-acting valve communicating with the sea by a pipe, or by a plug with a weighted lever. When the vessel rolls to starboard, her cisterns on that side will fill; and on the return roll, they will either be opened by the pressure of the water against the valves, or by the withdrawal of the plugs by the weighted levers, and the water then escapes. Claim—"The improved apparatuses, or any modification of them, applied to timber-loaded and other vessels laden with materials, the specific gravity of which is lighter than water, preventing the necessity of abandoning them at sea, by ridding them of superincumbent water, and enabling them thereby to carry sail."

SUGAR.—J. A. Steinkamp, London.—*Enrolled Jan.* 18, 1849.

Claim—"The use of cotton or other vegetable fibrous material (cotton, however, being preferred), cut into short lengths, in the refining of raw sugar, and to the cleaning, purifying, and refining of sugar-cane juice."

LETTER-PRESS PRINTING.—W. E. Newton, London.—*Enrolled Jan.* 18, 1849.—(*Communication.*)

This invention refers—1st, To various modes of distributing the ink evenly. 2d, To a Washington hand-press, with a peculiar lever, in which, as the pressman draws the handle towards him, the velocity decreases, and the pressure increases. 3d, To a self-acting inking apparatus for inking the type in a hand-press, as the frame travels in and out. 4th, To an apparatus for inking the type in a hand-press, which is worked independently, but in conjunction with the press. 5th, To a card-printing press, in which the inking and pressing are performed by the workman's foot, leaving his hands at liberty to feed in the cards, which, after they are printed, are delivered out at the other end of the press. The claim is a general one.

ELECTRIC LIGHT.—A. E. le Molt, London, Chemist. *Enrolled Jan.* 20, 1849.

M. Le Molt is a stout rival of Mr. Staite in the matter of the electric light. Without waiting to inquire into the question of priority, we shall give a digest of M. Le Molt's plans, and leave our readers to judge whether or not the invention is worthy of a dispute. In the first place, the patentee proposes certain improvements in electric piles for the production of light. Secondly, in the application of discs of carbon, so arranged as to revolve round each other, and, when they shall have completed one revolution, to approach, and again to come into proper relation to each other. One of the elements of the new electric piles, is a piece of carbon produced by the destructive distillation of coal, in the manufacture of carburetted hydrogen gas. This piece of carbon is electrotyped at one end, to which a strip of metal is attached, and the contrary end is attached in like manner to a cylinder composed of amalgamated zinc, forming the other element of the pile. The surface of the cylinder, the metal strip, and the electrotyped end of the carbon element, are all coated with a varnish, to modify the destructive action of the acids thereon, as also the influence of the zinc on the carbon. Copal varnish thickened by retort carbon is preferred. The carbon element is placed in a porous jar of nitric acid, and the amalgamated zinc cylinder is placed over, and encircling it—the whole being placed in a stoneware jar filled with a solution of sulphuric acid, of one acid and seven water. The carbon element may be cut out of the residuum of a gas retort, or moulded from a mixture of one part coke, three retort carbon, and one tar—subjected to pressure in moulds, after which it is dried by the atmosphere in the shade, and heated gradually in a close vessel for 36 hours, until it attains a bright red heat; it is then cooled for use.

The rotatory disc electrodes are to be of the purest carbon, such as retort carbon, cut to shape, and purified by immersion in a nitric and muriatic acid solution for 12 hours, and afterwards in a fluoric acid solution for a similar period. The disc electrodes are mounted on axes carried by the ends of a horse-shoe frame, jointed in the centre, so that the two arms may approach or recede from one another. The frame is held vertically, and the electrodes rotate in the same plane, or in planes at right angles to one another. The axes are driven by clockwork, with chain barrels. A coiled spring is fastened at one end to one arm of the frame, and at the other to the second arm, so that, when the discs have completed a revolution, the recesses in an arrangement of cams, come opposite their stops, and the electrodes approach each other. Claims—"1. The employing of that description or quality of carbon which results from a destructive distillation of coal or other matter used in the manufacture of gas as one of the elements, in an electric or galvanic pile; the employment of carbon moulded, subjected to pressure, and manufactured as described; electrotyping the ends of the carbon elements; connecting the carbon elements with the other elements used, by soldering, or other permanent fixture. 2. The application of discs of carbon as electrodes, so that they shall, when they have completed one revolution, be caused by the mechanism to approach towards each other, and produce a continuous electric light."

MARINER'S COMPASSES AND BAROMETERS.—D. Napier and J. M. Napier, London, Engineers.—*Enrolled Jan.* 20, 1849.

Claims—"1. The combination of suitable apparatus with a maintaining power, so as to produce a self-acting means of registering the direction of the head of the vessel, as indicated by the magnetic needle. 2. The method of registering upon a circular disc by a travelling point or pencil, as applied to barometers, and described. 3. The combination of a supplementary or auxiliary power, with apparatus for indicating and registering the speed of a vessel through the water, and the velocity of currents of water. 4. The measuring and registering of weight by a weigh-bridge or platform machine, having attached thereto apparatus such as described."

STAYS, BOOTS, SHOES, AND FASTENINGS.—W. Thomas, London, Merchant.—*Enrolled Jan.* 26, 1849.

Claims—"1. The mode of ornamenting stay fabrics by the introduction of pattern or extra threads into the shed during the process of weaving. 2. The arrangement of apparatus for taking up the work in weaving the gores of stay fabrics. 3. The arrangement and combination of apparatus for forming the gores, and weaving the plain parts of stay fabrics. 4. The apparatus for sewing stays or connecting parts of garments, wherein the needles used are made to pass through and through, and the thread drawn by a secondary apparatus. 5. The arrangement of apparatus for forming the stitch in tambour-work. 6. The apparatus for sewing, wherein the shuttle is used, in combination with the needle, to

introduce a second thread. 7. The mode of manufacturing hoots and shoes. 8. The method of connecting trowsers or gaiters to boots and shoes."

GAS METERS.—J. King.—*Enrolled Jan.* 26, 1849.

This invention refers, in the first place, to an apparatus which acts, and is acted upon, by the diaphragm, whereby the flexible portion is caused to act the first, and the inflexible part is held back; and secondly, to an arrangement for communicating motion to the registering frame of wheels. The lower part of the meter is divided into two compartments by the diaphragm, the inflexible part of which is fixed to an axle supported at bottom, whilst the top passes through a stuffing-box into the registering chamber. The top of the axle carries a cross-bar, one end of which is embraced by a weighted lever suspended on a shaft behind the meter—which resists the movement of the inflexible part of the diaphragm, until the flexible part has acted, whereby greater regularity is obtained. The other end of the cross-bar is connected with a sliding-bar, slotted to receive a weighted lever, which acts in changing the valves. Each compartment is fitted with inlet and outlet valves, attached together by a bar, fast to an axle. These axles pass through stuffing-boxes in the valve chambers, being connected with the apparatus before-mentioned, by a bent bar slotted for the weighted lever. Claims are general.

PRESERVING FERMENTED LIQUIDS.—Slough, Brewer. *Patent dated July* 29, 1848.

No specification enrolled.

SHAPING PLASTIC SUBSTANCES.—C. Hancock, London. *Enrolled Jan.* 29, 1849.

Claims—"1. An apparatus for moulding hollow wares, in so far as regards base chuck and the shifting moulds or pattern pieces connected therewith. The base chuck referred to is square, and has four dovetailed grooves cut lengthwise in its four faces for the reception of four pattern pieces, which are flat on their under faces, and have fillets by which they slide into the dovetailed grooves. All that is necessary when a change of pattern or design is desired, is to withdraw one set of moulds (from the chuck) and substitute another. 2. Another apparatus for moulding hollow wares, in which facilities are afforded for applying either hot or cold water, or steam, to the moulds, but whether used with or without the parts thereof relating to heating and cooling. 3. An apparatus for preparing plastic materials (for moulding) in so far as regards the construction of a vertical presser with a horizontal bed, filled with hot water or steam, whether such table is fixed or moveable. 4. An apparatus for moulding plastic substances into continuous lengths, with supporting cores of wire, cord, or other like tenacious substances, and several modifications thereof, in so far as regards the combination of a die-box, and a cylinder with piston, each working or operating in directions at right angles to, or more or less tangential to the other. 5. A modification of the preceding apparatus, which consists in adapting it to the production of short lengths of plastic materials of any required form (as mouldings, cornices, beadings, &c.), with interior supporting cores. 6. An improved apparatus for forming plastic substances into balls, in so far as regards its application to other substances than metals."

PRINTING INK.—G. W. Pratt, New York.—*Enrolled Jan.* 29, 1849.

Claim—"The mode of manufacturing printing ink, by employing rosin oil combined with colouring matters suitable for printing ink."

CASKS AND CUTTING WOOD.—J. Robertson, Liverpool, Cooper. *Enrolled Jan.* 29, 1849.

Patentee describes a machine for planing both sides of cask staves, by means of cutters. Also, one for planing and jointing the ends of staves; for compressing the staves; and for cutting the heads to the requisite size, and bevelling the edges; for cutting the interior grooves on the cask ends, and for punching the holes in the hoop iron. He claims the general apparatus.

COTTON MACHINERY.—E. G. Wilson, Bury, Tinplate Worker. *Enrolled Feb.* 1, 1849.

Claims—"1. The method of manufacturing tin drums, used in the above-named machinery, of larger-sized tin plates than has hitherto been customary, so as to have fewer seams or joints, and rounding them in suitable lathes. 2. Forming the driving pulley in mules of one piece with the rim of the body of the drum."

PROPELLING.—J. Taylor, London.—*Enrolled Feb.* 2, 1849.

This invention refers to a peculiar mould of a vessel; to a propelling wheel for such vessel; and to a mode of adapting this propelling wheel to vessels of the above construction. The mould of the vessel is of such a nature as that the midship section presents the appearance of an ellipse having the longest axis horizontal, which decreases (the perpendicular axis remaining the same) as the vessel approaches towards the stem and stern, until they are both equal, or the mould is circular; after which the horizontal axis decreases (the perpendicular one remaining the same) until the mould presents the appearance, at both ends, of the ellipse reversed, and finally merges into a wedge form. The keel is built on to the bottom, of such a depth as may be required, according as the vessel is destined for river or sea navigation. The decrease of the length of the horizontal axes of the ellipses should be in such gradation, as that a line drawn from stem to stern, intercepting the ellipses at their acute points, shall be an elliptic curve. The entering timbers above the water line should correspond to those beneath it. The improved propelling wheel consists of a flanged cylinder, fitted on its periphery with a number of floats, which may be convexed or concaved on their working surfaces. The longest, perpendicular to the chord of the arc of these floats, should equal the draught of the vessel. When the vessel is intended for canal navigation, one propeller is placed in the centre of the vessel, in which a suitable water-tight case is provided. The top of the case is fitted with a valve, which is closed by the pressure of the inside water, and opened when that pressure is removed, to admit the external atmospheric air to the wheel case. Claims are—"the mould of the vessel, the propelling wheel, and placing the propeller in cases with collapse valves."

JACQUARD MACHINERY.—D. Mackenzie, London, Manufacturer. *Enrolled Feb.* 5, 1849.—(*Communication.*)

Claims—"1. The employment in Jacquard machinery of an endless band of paper, gutta percha, or other suitable material, on which the pattern has been punctured when passed round a cylinder attached to the batten. 2. The employment of the compound needles, which are actuated by the passage of the punctured paper over the revolving cylinder, and the mode of causing them to act upon some one or other of the horizontal needles of the lifting bars for the production of the pattern in the fabric. 3. The mode of bringing the needles into a position ready to be acted upon by the next succeeding portion of the pattern on the endless band, either by causing the revolving cylinder to fall so as to withdraw the endless band from contact with the needles, or by causing the case carrying the whole of the needles to slide up the batten a short distance to effect the same purposes. 4. The employment of needles of the form represented and described, which needles act on the horizontal ones, and so determine which of the warp threads should be raised, and which left stationary. 5. The employment of a frame for supporting the needles, constructed as represented and before described. 6. The employment of the fixed curved perforated plate, over which the endless pattern-band is caused to pass by the pitch wheels. 7. The combination and arrangement of means for lifting the needles out of the holes in the endless band when the design has been transmitted to the fabric, so as to allow of the passage of the next succeeding portion of the pattern over the curved plate, and underneath the points of the needles. 8. The peculiar arrangement and combination of parts for transmitting motion to the improved Jacquard machinery. 9. The mode of producing the design upon a fresh endless band during the working of the Jacquard loom. 10. The application of an endless band of paper, gutta percha, or other suitable material, having the tune punched out therein, to the actuating of Jacquard machinery for the production of sounds in musical instruments. 11. The employment of an endless band of gutta percha, or any of the compounds thereof, having the pattern punched out upon it, for actuating the needles which act on the horizontal needles, and thereby determining which of the needles shall be raised, and which left stationary. 12. The arrangement and combination of the various parts constituting the reading apparatus before described, when used to place the whole of the required punches in the punching plate, before any of them are driven through the card or other substituted material."

GLASS AND GLAZED SURFACES FOR NAUTICAL AND ARCHITECTURAL PURPOSES.—D. Newton, Macclesfield, Merchant.—*Enrolled Feb.* 7, 1849.

Mr. Newton proposes to apply glass, as a terminal for masts and yard-

arms, for repelling lightning. Also, to construct vanes of glass, and to employ the same material for interior and exterior decorations of buildings. He also substitutes it for ebony in the keys of pianos, and isolates such instruments by glass legs, and applies it for index letters, signs, &c. When used for ornament, he heightens its effect by quickening the glass, or by placing tinfoil behind it.—No claims are made.

STEAM-ENGINES AND BREAKS.—S. Thornton, Birmingham, Merchant, and J. E. M'Connell, Wolverton, Engineer.—*Enrolled Feb. 7, 1849.*

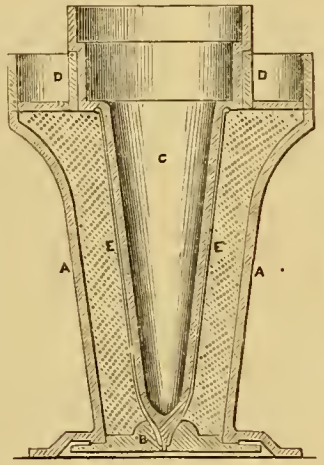
Claims—"1. The arrangement and construction of parts of a piston, in which the packing rings are adjusted by conical surfaces acted upon by elastic discs and spiral springs. 2. Dividing the chimney into several shafts, into which a corresponding number of steam-pipes are made to exhaust. 3. The arrangement and construction of eduction valves, as described. 4. The coupling arrangement. 5. The mode of placing the buffers. 6. The arrangement and combination of apparatus for signalizing, which at the same time causes the breaks to be applied."

REGISTERED DESIGNS.

APPARATUS FOR CASTING SUGAR-MOULDS.

Registered for Messrs. Campbell *and* Macnab, *Shaw's Water Foundry, Greenock.*

Greenock has, for a lengthened period, held an honourable position as the seat of a considerable sugar manufacture, which has there received many valuable improvements. In the present design, Messrs. Campbell and Macnab, who have devoted great attention to the machinery of the trade, have sought to accelerate the process of casting the metal moulds in which the refined loaves are cast. Our engraving gives a vertical section through the centre of the mould-box, showing a sugar-mould cast within it. A, is the lower sand-box, in which the mould is formed; it has a closed bottom fitted with a support, B, acting as a foot-step for the metal mandril, C, which forms the main feature of the improvement. D, is the upper loose box, of an annular shape, fitted to surround the upper portion of the mandril, C, which is thus secured in a true vertical position. The space, E, represents the thickness of the metal mould cast between the interior surface of the sand and the exterior of the mandril.



1-12th.

Sugar-mould founders will readily see the economy which must result from the use of this apparatus; for whilst a great amount of time is saved in the operation of moulding, the castings will be true, and of better surface than can be obtained in the old way.

STOP-CUTTING APPARATUS FOR TILE MACHINERY.

Registered for Mr. John Key, *Wemyss Colliery, Fife.*

Mr. Key's invention has reference to a method of stopping the action of tile machines during the time occupied by the cutting-wire, in severing the lengths of pipes or tiles. He shows his mechanism as adapted to Ainslie's tile machine, although it is equally applicable to any other of the class. The main driving-shaft, which works the gearing of the machine, carries a loose internally-coned driving strap-pulley, which fits an external cone-disc sliding loosely on a fixed feather in the shaft, and set so as to be put in or out of gear with its counterpart cone, by a hand-lever, at pleasure. This lever turns on a stud carried by the frame of the machine, a helical spring being adapted to hold it, so that it keeps the two cones in contact whilst the machine is in action.

The vertical cutting-frame carries a side projecting piece, working up through a slot in the bracket which supports the lever spring, and this projection acts in its ascent and descent, upon the end of the actuating lever of the cones, so that, whilst the wires are cutting off the tiles, the cones are thrown out of gear, and the driving-strap on the interior-coned pulley turns only this pulley, until the cutting action is over, when the helical spring of the lever brings the two cones again into gear. It has always been an objection in the machinery, that, as the newly-formed tile or pipe issued from the die in a continuous delivery, the cutting-wire could not make a sharp, clean, and square section; but, by stopping the delivery of the tile just whilst the wire descends, Mr. Key is enabled to completely remove this difficulty.

The cutting apparatus is worked by a small rope-pulley on the end of the main shaft, driving a larger one placed on an upper shaft, carrying a pinion gearing with a large spur-wheel. This wheel has a stud-pin in its side, working in the slotted end of a connecting-rod attached to a short lever on the lower cross-shaft working the cutting-frame. The slot in the connecting-rod being made of much greater length than the travel of the actuating-pin in the wheel, the rod receives only a short movement at each end of the stroke, so as to give the due amount of cutting action.

REVIEWS OF NEW BOOKS.

Letter to Viscount Ebrington, M.P., on Proposed Modifications and Extensions of the Water Supply of Plymouth. By N. Beardmore, C.E. Plymouth: R. W. Stevens. London: Weale. 1848. Pp. 20.

The water supply of towns appears to be gradually securing the attention it deserves; and we shall shortly have only to wonder that it has been so long a matter of mere secondary consideration. The letter before us embodies a practical report on the improvement of the supply of the three towns of Plymouth, Devonport, and Stonehouse, which places, although distinct in name, may be considered as one large town.

It appears that Plymouth was first systematically supplied with water by Sir Francis Drake, he having leases of the mills he should erect on the water-course, or leat, as it is locally called. The water is taken from the river Plym, or Mew, and runs in an open winding course, for a distance of 18 miles, to Plymouth, where a portion of it falls into two small reservoirs, about 135 feet above high water, and hence the distributions are made. At this point, also, a diverging branch takes about two-thirds of the entire supply to a mill-course to the sea at Millbay. However viewed, in relation to the well-being of the town, this plan possesses numerous objectionable features, which Mr. Beardmore seeks to remove by arrangements unfolded in his letter. By the time the water arises at the lower part of the town, it becomes perfectly unfit for domestic purposes, as for some half-mile it is stored up to work a mill situated near the junction of the stream with Millbay. This portion acts as a receptacle for a large amount of filth, and, whilst it is thus irrecoverably polluted, it produces very injurious effects upon the locality through which it passes. Mr. Beardmore's proposal is, to abandon the whole of the water-power, so as to leave the supply for the town's use untouched. He says,—

"Assuming the available fall to be about fifty feet, and the supply ten cubic feet per second, which is very much beyond what the miller can ever obtain, the power is equal to ·83 horse-power per foot of fall, or 50 × ·83 = 41·50 horse-power in toto, which, if valued as steam-power to be extinguished in sixteen years, would represent a loss to the Corporation of £580 per annum. This sum of money may appear at first sight large, but of course the rental of the mills at present, and the value of the premises, would have to be deducted in looking at it as the actual cost to the town.

"Twenty years since, an engineer deemed he was giving a fair quantity when he supplied eight to ten gallons per head of the population; now it is generally allowed that this is utterly inadequate, and from twenty to twenty-five gallons per head is considered the minimum allowance. I have lately been engaged in the improvement of the supply of water to the city of Edinburgh, and have found that there will be ample use for thirty to thirty-five gallons of water per head per diem; while in some extensive designs that I was engaged upon for improving the supply to Glasgow (which is a manufacturing town), the quantity was estimated at fifty gallons per head."

According to a report on the sanatory condition of Plymouth, by the Rev. W. J. Odgers, 753 houses have no water laid on; and out of 4,045 supplied, 437 only have cisterns. Nothing could furnish a stronger case for the adoption of a constant supply, than these very facts.

"With the astounding number of persons living in single rooms in Plymouth, there should be a systematic arrangement for a vertical pipe, with branches to the different floors of houses let off in rooms, like the plan of supply up the common stairs of the flats in Edinburgh and Glasgow, where, of course, each *tenant is charged a separate water rent.* Now a charge of three shillings per annum, allowing a deduction of twenty-five per cent. for payment by the landlord, would at once bring accession of revenue to a large amount, and be an incalculable boon to the poorer community. An objection may be taken to the apparent expense of this arrangement; but if galvanized wrought-iron were used for the vertical pipes, it would be small. If a service were combined with a sink and waste-pipe for each floor, the cost would be thus—

	£	s.	d.
Thirty feet of vertical iron pipe at 8d. fixed, including three branches,	1	0	0
Three pipes and taps,	0	10	6
Three sinks of slate, to be erected in staircase angle,	1	4	0
Waste pipe (stack pipe available),	0	15	0
Cost per house with three floors,	£3	9	6

The author is fully alive to the advantages to be derived from a constant high-pressure supply in cases of fire; and, with the example of the Gorhals works before us, we fully coincide with him. A good map of

the locality, which accompanies his letter, shows how he would make provision for a six days' reservoir supply for 150,000 people, allowing 36 gallons per head per day, with a head of 275 feet. For the precise views which he entertains, we must refer the reader to the pamphlet itself, believing that, although its matter is necessarily essentially of a local nature, yet many hints and good practical suggestions may be gathered from it.

DAVIES' ROTATORY ENGINE: an Experimental Inquiry. By W. DREDGE, C.E. London: Williams & Co. 1849. Pp. 42. Woodcuts.

Our own report upon the working of this engine, leaves us little to say in reference to Mr. Dredge's pamphlet. He confesses his once firm prejudice against the system, but makes full amends by the explicit recantation contained in the present pages. As a statement of the results of his experiments upon the single-piston engine at Messrs. Edelsten and Williams', we extract the following:—

"On Wednesday, March 8th, 1848, whilst the ordinary work of the mill was upon the engine, the pressure of steam in the boiler being 18 lbs. per square inch, (which just gave sufficient power to the engine without any escape from the safety-valve,) I caused the quantity of water and the weight of the coals to be accurately registered, and found, by repeated experiments, that the quantity of water evaporated during that time was 9·8 cubic feet, and that the coal consumed was exactly 86 lbs. per hour.

"The coal employed in the experiments was the ordinary Staffordshire engine slack, which cost, delivered at the manufactory, 5s. per ton. I have, however, thought it best to reduce it in calculation to the best Welsh coal, one pound of which, by experiment, is found to evaporate 9·5 lbs. of water; the quantity of coals, therefore, of this quality, which would be consumed by the engine per hour, is

$$\frac{9{\cdot}8 \times 62{\cdot}5}{9{\cdot}5} = 64{\cdot}47 \text{ lbs.}$$

"The engine made seventy revolutions per minute. The annular space between the piston and exterior cylinder was, therefore, filled seventy times per minute; consequently $70 \times 60 \times 2 = 8{,}400$ cylinders of steam were consumed per hour.

"The cubical contents of the annular space within each cylinder is 1.695 cubic feet; but as the cam moves the steam-stop, and closes the ports before the piston has completed its revolution, only ·6 of this space becomes filled with steam at the full pressure; but after the port is closed, the steam expands through an additional ·03 of the circle.

"The quantity of steam consumed by the engine in one revolution of the piston is, therefore, $1{\cdot}695 \times 6 \times 2 = 2{\cdot}034$ cubic feet; whence the number of cubic feet of steam used by the engine per hour is $2{\cdot}034 \times 70 \times 60 = 8542$. At a density of 18 lbs. per square inch, steam occupies a volume of 830 times as great as the volume of water from which it is raised. Hence $9{\cdot}8 \times 830 = 8134$ cubic feet is the volume which 9·8 cubic feet would occupy when raised into steam at a pressure of 18 lbs. per square inch; but the space it actually filled in the cylinder was 8,542 cubit feet, therefore the steam, after leaving the boiler, must have expanded from 8,134 to 8,542 cubic feet, and the elasticity being inversely as the space occupied, it follows that 17·14 lbs. was the pressure of the steam on each square inch on the piston.

"The area of both pistons is $3{\cdot}5 \times 13 \times 2 = 91$ square inches, the distance through which the steam acts, or rather through which the centre of pressure of the steam acts, in each revolution, is

$$\frac{\text{Ins.} \quad \text{Ins.}}{\frac{17 + 24}{2}} \times 3{\cdot}1416 \times {\cdot}6 = 3{\cdot}22 \text{ feet.}$$

Hence the mechanical effect, or the theoretical power of the engine,

$$\frac{17{\cdot}14 \times 91 \times 3{\cdot}22 \times 70}{33000} = 10{\cdot}65 \text{ horses.}$$

"To which must be added the work done by the steam expanding after withdrawing the slide. This space, ·161 feet, is too small sensibly to affect the density of steam in the cylinder, and therefore it increases the power of the engine ·53 horse; which, added to 10·65, gives as the actual value 11·18 horses power.

"In order satisfactorily to ascertain the amount of force absolutely expended, a friction-break was applied.

"The pressure of steam on the boiler and the speed of the engine were kept the same when the friction-break was on, as they were during the day while driving the machinery in the manufactory, and the result was, that the friction-break showed a power of 10·2 horses actually given off in doing useful work. From which it appears, that about one-horse power was absorbed in the waste, condensation, friction, &c. of the engine; or, in other words, that the useful mechanical effect given out by the engine was only about 10 per cent. less than the full mechanical power due to the steam.

"The quantity of Welsh coal which would be consumed per hour is 64·47 lbs., which gives an average of 6·3 lbs. per horse-power per hour. This is a small quantity of coal per hour for a high-pressure engine; but it is not that altogether which tests the value of the engine, for it is evident that the quantity of coal consumed must in a great measure depend on the evaporating power of the boiler."

The second portion of the pamphlet is devoted to a general description of the double-piston engine, referred to in another portion of our pages of the present month.

The accuracy and care with which Mr. Dredge's "Experimental Inquiry" appears to have been undertaken, give an air of trustworthiness to his deductions, which are characterized by an acute discrimination in many of the practical points of the subject. Those who are desirous of possessing fuller information on the real efficiency of the engine, than we have been able to furnish, may consult the work with advantage, as it shows what a well-contrived rotatory engine can do.

THE PHYSICAL PROPERTIES OF STEAM, in Relation to the Mobile Matter of the Steam-Engine. By John Curr, of New South Wales. London: John Williams & Co. Pp. 48.

The author of this *brochure*, nothing daunted by the most unequivocal reception from the engineering press, which he experienced on the publication of his work on railway locomotion and steam navigation, again launches forth on the world his thirty-year-old experience, rendered mellow by time, and interesting by its antiquity. In the publication before us, Mr. Curr's object appears to be—first, in the words of his old master, Emerson, to snarl at what he does not understand, and consequently cannot mend; secondly, to establish a new theory of heat, on which he founds his steam scale of temperature; thirdly, to prove the inapplicability of the expansion principle in steam-engines; and fourthly, to explode the received theories of boiler explosions. We do not undertake to examine the author's theories in detail,—the incomplete and singular style of the work disables us from doing so. He, however, condemns the prevalent theory of latent heat, terms it a fiction impressed upon the imagination of philosophers, and considers that Watt's deductions from his experiments on heat, are marks of obtuseness scarcely to be equalled, excepting in the course of mathematics by Dr. Hutton. To any of our readers, who have more leisure than ourselves to follow the author through his calculations, we cordially recommend Mr. Curr's pamphlet as a capital *praxis* on the received principles of the steam-engine.

CORRESPONDENCE.

IS IT SAFE TO USE GLASS IN SAFETY-LAMPS?

Having introduced the use of glass in safety lamps,* and finding that some parties are alarmed at the very idea, I propose now (knowing that your journal comes into the hands of many scientific and practical men connected with collieries) to examine their objections, in order that the fallacy of such objections may be exposed, and their fears allayed. The extreme frangibility of glass is said to expose it to breakage from two causes, viz.: external violence, and internal heat. The danger is said to be in the liability of the glass to be broken by either of the above causes, although it is readily admitted that nothing (as the glaziers say) heats glass for light. They thus use the word glass *generally*, and so conclude that under any circumstances it is unsafe to use it. Now I can, from experiment, state, that both objections are unfounded, provided that the simple precautions I recommend be attended to. Thin crown and German sheet-glass are unfit for the purpose, I admit; but in all cases I have used and recommended *thick plate-glass*. Glass increases in strength as it increases in thickness, so much so, that it is advantageously used on ships' decks as a flooring, to admit light into the cabins below, and also as a steam-guage and water-indicator in boilers. These uses prove that it can be made "strong as a board." Now, for safety-lamps, it need only be thick enough to withstand trifling forces, such as the blows from fragments of coal, &c., and not to resist all possible violence. For this purpose, and to sustain all the rudeness to which safety-lamps are legitimately liable, the plate-glass must be from $\frac{1}{4}$ inch to $\frac{1}{2}$ inch thick, but never less than $\frac{1}{4}$ inch. If the glass be well put in and puttied, and the edges overlapped by pieces of tin soldered inside the lamp, it will be as strong as wire-gauze, and not liable to dents or bruises. It will also be uninjured by heat from the firing of the gas inside; and should the glass ever, by any mishap, be cracked, no danger would ensue, because the glass would not fall out if properly put in. Since "what one man makes, another can destroy," no lamp can be made strong enough to resist wilful violence. There can never be a very good light obtained from a wire lamp; and therefore, to remove the great objection to the use of safety-lamps, I do unhesitatingly recommend plate-glass-fronted lamps. Wire-gauze will always intercept much light; and therefore, to effect a radical cure, it is necessary to use glass. Plate-glass will suit best for candle-lanterns, where the flame is constantly lowering; but for oil-lamps, a thick glass lens (if preferred) may be used instead.

These remarks have been penned with a view to reconcile parties to the innovation, and to show that there need exist no apprehension for the safety of the plate-glass lamps. I trust enough has now been said to prove that glass is admirably adapted for the purpose, provided it be used according to the directions given above.

JOHN CRANE.

Birmingham, Feb. 8th, 1849.

[We think Mr. Crane has made out a good case for the glass-fronted lamp. No one can doubt the superiority of the light afforded by it; and any force sufficient to fracture the glass, would certainly injure the wire-gauze.—ED. P. M. J.]

THE RESISTANCE TO RAILWAY TRAINS.

I don't perceive what H. W. of Paddington can mean by sending to this journal an article headed as above, unless that he hopes, by a side

* See page 150, P. M. Journal.

wind, to get rid of the main charge I have made against engineers, experimenters, mathematicians, and railway directors, for having misspent the money of the shareholders.

Amongst other *derelicta*, he has charged me with having neglected the side wind, which, he says, has been proved to have a considerable effect. But this charge falls innocuous; for if H. W. will turn to page 59 of this journal, to which I previously gave a reference, he will find that, in the very experiment on which my estimate of the atmospheric resistance was made, "scarcely a breath of air was stirring,"—so this charge is defunct.

He also charges me with having knocked off one-third of the weight of the wheels and axles of the engine and tender. Here again he is in error, for the deduction of one-third was on the gross weight of the engine, tender, and train: the deduction was therefore a mean of the whole; and as I assume the wheels and axles of the carriages to exceed a third of their entire weight, this charge also falls, unless H. W. can show the assumption to be an error.

I am further charged with jumping at the area of the train opposed to the wind; but as to this, H. W. has jumped himself into a gross mistake. There was no wind for me to jump at, for it was almost a perfect calm. I acknowledge having shown the resistance of the air, when at rest, to the train passing through it; but he has forgotten that the two cases of the wind in motion against a plane at rest, and that of a plane in motion against the air at rest, differ exactly as 1 to 2.

As an apology for the pressure on the piston not having been given, H. W. says there is much difficulty and danger in taking off indicator diagrams from the cylinder of a locomotive, when going forty-three miles an hour; and so let there be, for the temperature of the steam by Fahrenheit, or any other known scale, is all that is requisite; and if he cannot reckon what is its pressure, it shall be done for him, when the shareholders will have the satisfaction of seeing how the fuel is expended, as truly as the merchant, whose accounts are kept by double entry, knows them to be correct, after being checked—the debt and credit sides of his ledger balance.

H. W. charges me likewise with having left out of consideration the state of the rails. I have assumed the railway to be workmanlike, and in fair condition; for, if otherwise, it would have been a disgrace to those engaged in the experiments. But taking this charge in conjunction with the resistance arising from concussions on an ill-laid railway, he will find neither have been neglected; for a set-off was made of the resistance arising from the two causes, against the diminished friction consequent on the reduced gravity of a train in motion, when compared with the same at rest,—a principle which, if not admitted as true, I am prepared to establish.

H. R. seems to think that of late I have occupied too much space in this journal. I am not insensible of the honour already done me by the editor, and now crave his indulgence for a few general observations.

I had conceived the detection of error in principles put forth by great men both a useful and honourable occupation, and that the more weighty the dignities conferred by this or that college, the more valuable such exposition would be to mankind.

H. W. would have the shareholders to believe, that the resistance to railway trains is one of the most difficult subjects with which engineers have had to deal. This I take as a confession, that, notwithstanding all experiments, engineers have as yet discovered nothing.

JOHN CURR.

7 *Upper Penton Street, Jan.* 1, 1849.

QUESTION IN FRAME-WORK.

The case submitted by R. S. is not so simple as he imagines; and it is no wonder he finds it belonging to a branch of mechanics which is very imperfectly understood, and that it has a good deal puzzled him.

The requisition is for a simple proof of the amount of force acting upon each of the various points, A, B, and C, together with a simple and general solution.

The term force implies motion, otherwise the question might have been considered as statical, which was probably intended; and if so, the stress or pressure should have been required, and in which sense I will suppose the question to have been put; moreover, the pressure may be distinguished as perpendicular and lateral, or horizontal. The perpendicular pressure on C will be exactly ten tons, and on each point, A and B, it will be five tons, *plus* half the weight of the frame.

The lateral pressure, or the pressure tending to elongate the distance of the points A and B, will depend on the rigidity of the material employed, as respects deflexure from compression, and its tensile strength without perceptible elongation; for if the material be perfectly rigid and perfectly strong, there is no tendency to elongate the space from A to B, and therefore no horizontal strain or pressure.

A general rule is therefore impracticable, and a simple rule cannot be given, as the solution must depend on the degree of elongation or deflexion, to arise in any case of given form, dimensions, and the respective metal used in its different parts, with the ratio of dilatation and depression in length, by given weights acting thereon.

Therefore, the only simple and practically useful solution of any case must be given from actual experiment by model.

JOHN CURR.

THE ELECTRIC LIGHT FOR MINES.

Permit me to call the attention of some of your scientific correspondents to a subject which of late, in particular, has excited a most painful and deeply-absorbing interest in the minds of many—namely, the dreadful accidents and frightful loss of life in our mines, arising from the combustion of inflammable gas, by its coming in contact with, and being ignited by, the lamps or candles used for lighting.

There really is no longer any excuse for not using what must be considered the very best of all artificial lights, namely, that produced from the voltaic battery, especially now it is so much improved, as well in its self-sustaining powers of decomposition, as in its capability of producing a continuous light, and for which several gentlemen have recently obtained letters patent.

The great recommendation of electricity, as a lighting medium, is its power to illumine when immersed in water, as efficiently as out of that medium. Any number of lamps (mere glass globes filled with water) can be illumined from such batteries as above alluded to, sufficiently to light up the most extensive mine most thoroughly and effectually, for all the purposes of mining operations, and, it is thought, more economically than by any other means.

It will be seen, that by the use of this system of lighting, the possibility of the combustion of gas by ignition is totally precluded, the light being immersed in water, and therefore incapable of igniting.

I offer you the above, verily believing the suggestion capable of being improved to the fullest extent; and I have no doubt, that among your scientific friends, some might be found to take an interest in this subject, to develop more comprehensively than I am able to do, the details necessary for such a most desirable system of lighting, which would insure safety to the immense number whose lives are spent in the bowels of the earth. The electric lighting would not consume the little life-giving air that is in the mines, which certainly is another great reason for its extensive adoption. E. DOMMETT.

London, 3, Red Lion Square, 14th Feb. 1849.

[Practically speaking, the several parties who have so lately patented modifications of the electric light, have left the subject in the condition in which they found it. Every case which has come before us, has tended only to prove to us the utter inapplicability of the light as it now is for anything like general use, still less for the rough management of coal mines. Whatever may be ultimately made of the invention, it is certain that just now it is valueless.—EDS. P. M. J.]

CONDENSATION OF STEAM.

The question proposed by F. H. P——e does not admit of a solution which would be verified in practice, unless the vessel containing the water be surrounded by steam of uniformly increasing temperature, such increase corresponding exactly with the increase of the temperature of the water within the vessel; for if the vessel were surrounded by the atmosphere, there would be a constant radiation of the caloric, proportional to the difference of the true temperature of the atmosphere, as compared with the temperature of the water and steam contained within the described vessel. The water deposited, in consequence of such radiation of caloric, cannot be determined, as the case involves time, and the material of which the vessel is composed bears a part in the question. On the other hand, if the external temperature were to exceed the internal temperature, the quantity of water at the end of the experiment would be less than in the first case, as the water would imbibe the temperature of whatever surrounds the vessel.

Moreover, the question would be affected by the manner in which the steam is generated: for example, the density of steam generated in a locomotive boiler is about three times that of steam generated in a boiler, the surface of water in which is so proportioned to the heating surface, that the density of the steam is inversely as its pressure; and, on which account, I think it may be some day discovered, that two or three times the due quantity of fuel is consumed by a locomotive-engine, as compared with the consumption when steam is generated in the old-fashioned boiler.

The answer to the question would also vary according to the degree of temperature of the cold water put into the vessel; but if it may be

taken at $68\frac{2}{3}°$ Fahr., that a cubic inch of water will produce 1,728 cubic inches of steam, of a pressure equal to 30 inches of mercury, and that water is at its maximum density at 40° Fahr.; and further, that no radiation of caloric take place whilst the water is being heated, and that there is no absorption of temperature by the vessel containiug the water and steam;—then, as I have elsewhere shown, 6 cubic inches of water would become 7, heated by steam of the pressure of 1 atmosphere, when cooled down to $68\frac{2}{3}°$ Fahr. And as $6 : 7 :: \frac{1728}{2} : 1008$—the quantity of water in the vessel, in case it had to be raised to the boiling point only; and which $\times \left(\frac{60}{15}\right)^{\frac{1}{2}} = 2$, (the relative density of steam of 60 lbs. pressure to that of 15,) the product is 2,016 cubic inches. Hence, the vessel would he filled with water before it is raised to the required temperature.

JOHN CURR.

London, Feb. 5, 1849.

THERMOMETRIC OBSERVATIONS.

I am afraid I must not look to your correspondent, Mr. Curr, for a solntion of my little problem regarding the thermometer. There is no difficnlty in fnrnishing an approximate arithmetical solution, correct enongh for any practical purpose; and, moreover, I can manage an exact solntion of it—that is to say, one deduced mathematically from the principles assnmed—without requiring assistance; but I cannot do this *neatly*, and the thing wanted is a neat mathematical solution. From the tenor of Mr. Curr's remarks, it is abundantly obvious that this is quite out of his way. He declares that it is impossible to furnish the required solution, hecanse the principle of the thermometric scale is not correct. But, in truth, it little affects the possibility of the required solution whatever the principle of the thermometric scale is, provided only it has a principle at all; and there is a mathematical principle implied in your correspondent's rows of decimals, thongh he does not appear to be aware of it, upon which this and similar problems do admit of an exact solution.

Mr. Curr seems qnite insensible to the ridicule attaching to his long lines of figures in a qnestion of this sort, and does not perceive why I should have "twitted him with the minute accuracy of sixteen places of decimals;" nay, he recnrs to them with evident complacency, and seems to regard them as the instruments of a notable discovery on which he plumes himself.

It is obvious, on the first glance, that although all his data were mathematically correct, every one of his cherished strings of figures is a mere expression of laborions error through at least one-half of its extent, his circular mnltiplier being taken at ·5236; whereas, to be consistently minute, he shonld have done this element the jnstice of carrying it to its fair share of extension, when it would have assumed the neighbouring appearance of ·5235987755982989. This grave omission of 12 significant digits vitiates all his results. It involves no *principle*, however, and may be remedied by a painstaking application of the multiplication table. The discovery is announced in these words—"But I may be permitted to add, as an egotistical conceit, that I claim the merit of being the first who has shown the error in the principle of the thermometer arising from the cause described, which I have heretofore twice asserted in print—*that the contents of the bulb of a thermometer must be in a definite proportion to the section of its stem.*"

It is very clear that these words cannot be a statement of his discovery, whatever it may be, for they contain no meaning at all. The contents of the bulb being a solid, or figure of three dimensions, and the section of the stem being a snrface, or figure of two dimensions, there cannot exist, in the nature of things, any proportion between them; the fundamental idea of proportion involving reference to a common unit, which can have no place in heterogeneous quantities.

We are thns left in some measnre to conjecture the nature of the discovery, which, however, I take to be this—that, according to the law of expansion, which Mr. Curr adopts for glass and mercury, the ascent of the latter in the tnbe is not strictly in the ratio of the temperatures.

Mr. Cnrr employs the received coefficients of dilatation, and assumes them to be exact expressions of a physical law, instead of what they really are—namely, close and convenient approximations, accurate to an extent snfficient for practical purposes. Glass happens to be a solid; and, as snch, its *linear* expansion is the natural subject of measurement. Mercury happens to be a fluid; and, as snch, its *cubical* expansion is natnrally observed. The absolute expansion in both, within the ordinary limits of temperature, is small, and the curve of the ordinates approaches so near to a straight line, that for practical purposes it is assumed to be such, though it is not pretended that this is the rigorous expression of a mathematical law that can endure the torture of sixteen places of decimals. Indeed, it is well known, and was acknowledged long ago by De Luc, Dalton, Dr. Ure, MM. Petit and Dulong, that there is a variation in the expansibility of mercury, and that it increases slowly as the temperature augments. From -40 to $+212$ this variation is scarcely appreciable, and certainly falls within the limits of errors of observation on ordinary instruments. Messrs. Petit and Dulong found the expansion between zero and

$$\left.\begin{array}{ll} 100° \text{ Centigrade,} & = \frac{1}{5550} \\ 200° \quad " & = \frac{1}{5425} \\ 300° \quad " & = \frac{1}{5300} \end{array}\right\} \text{for } 1° \text{ Centigrade.}$$

Now, Mr. Curr, proceeding upon the supposition that the *linear* expansion of glass is in the direct ratio of the temperature, and that the *cubical* expansion of mercury follows the same law, finds, of course, that the combination of these data produces a disagreement with the assumption, that equal increments of heat produce equal increments of elevation of the mercury in the tube throughout the scale. This profound conclusion he reaches with the help of his decimals, and parades it with the importance of an especial discovery. But to what does this amount when stripped of its cumbrous load of arithmetic, but to this very axiomatic truth, that if two numbers be in arithmetical progression, their cubes are *not* in the same progression? Take his own case: suppress the circular multiplier as being common to all the terms, and represent the quantities by general symbols for the sake of distinctness, and we have Mr. Curr's expressions, (a), (b), (A), (B), as follows:—

$$(a) \ldots\ldots (1+g)^3 = 1 + 3g + 3g^2 + g^3.$$
$$(b) \ldots\ldots (1+2g)^3 = 1 + 6g + 12g^2 + 8g^3.$$
$$(A) \ldots\ldots 1 + m.$$
$$(B) \ldots\ldots 1 + 2m.$$

We are directed to subtract (a) from (A), and (b) from (B), and the resulting discovery is, that the latter remainder is more than double the former; in short, that $12g^2 - 8g^3$ is more than double $3g^2 - g^3$.

H. R.

Glasgow, Feb. 15, 1849.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

FEBRUARY 6, 1849.

JOSHUA FIELD, ESQ. PRESIDENT, IN THE CHAIR.

The paper read was a "Description of the Abattoirs of Paris," by Mr. R. B. Grantham, M. Inst. C.E. The subject was treated of chiefly in connection with the sanatory question, at present occupying so much attention; the author being of opinion that much public benefit would be derived from the introduction of similar establishments into the city of London. The paper commenced by pointing out the advantages resulting from the method in which the butchers' trade was carried on in Paris. It was stated that this trade was regulated by a nnmber of restrictive enactments, and conducted under the control of a syndicate or guild, who advised with the government upon all questions relating to the abattoirs and markets.

It appeared from the account, that, previous to the opening of the abattoirs, in 1818, slaughter-houses existed in the crowded and populous districts of the city; and that, as at present in London, the passage of the cattle through the streets, and the consequent nuisances, were found to be intolerable. The five abattoirs were designed with great care, to obviate these evils, and were generally allowed to have fully accomplished the purposes for which they had been constructed; they had been of great public service, in rendering Paris free from those nuisances which were still permitted to exist as such blots on the general cleanliness of the city of London.

The abattoirs were erected within the barriers, opposite Montmartre, Menil-Montant, Grenelle, Du Roule, and Ville Juif, at an average distance of a mile and three quarters from the centre of the city.

The paper, which was accompanied by detailed plans of each abattoir, and a general drawing of their arrangement, described minutely their construction, as well as the mode of slaughtering the cattle, the melting the tallow, and other details connected with the trade carried on therein. All the buildings were stated to be abundantly supplied with water, well ventilated, and kept in the highest state of cleanliness.

Tables were given of the number of cattle, sheep, and pigs killed, and the amount of tallow melted during the last four years; and a statement was appended, from which it appeared that the revenue (derived from tolls, charged upon all the meat killed, at per kilogramme,) amounted during one year to £47,608 16s., that the total expenses were £4,958 12s., leaving a profit to the city of Paris of £42,650 4s., or about $6\frac{1}{2}$ per cent. upon £680,000, the original cost of all these establishments. The paper argued that, if this revenue was obtained from the tolls, &c., for slaughtering meat for a population not exceeding one million souls, who did not consume anything like the amount of animal food that Englishmen habitually indulge in, how much greater would be the profit of such establishments for London, where there was a population nearly approaching three millions of souls, in whose behalf such strenuous exertions were now making for the increase of sanatory regulations

and more ample snpplies of water, and everything tending towards a higher state of cleanliness and health.

In the discussion which ensued, and in which Mr. E. Chadwick, Professor Owen, Messrs. Leslie, May, Allen, Ransome, Elliott, Armstrong, and others, took part, very interesting statistical facts were given, in connection with the present state of the Smithfield Market, and the evils attendant upon the animals being driven through the streets, and then killed in a state of fever, when the blood was in a condition to induce rapid decomposition of the meat, and render it nnfit for food. In proof of this, it was stated that, in the summer, quantities of fine meat were frequently obliged to be thrown by the butchers upon the offal heap, within thirty hours from tbe time of the animals being slaughtered—putrescence being so rapidly induced by the deleterious atmosphere of the slaugbter-house pervading the place where the meat was kept.

Among the numerous advantages of a new and spacious establishment, like that of Islington Market, to which public slaughter-houses are to be attached, would be the direct contact of the cattle-sellers with the hutchers, and, by thus avoiding the intermediate profit of the middle men, the latter would be enabled to sell their meat in better condition, and at a more reasonable rate, to the publlic.

The present objectionable system of Smithfield appeared to be upheld merely as a question of revenue to the city, for which tbe public not only paid heavily, but suffered severely by common annoyance, and by the deleterious effect on the pnblic health.

Modifications of the Paris system were shown to be perfectly adapted even to the actual state of the butchers' trade in London; that the internal arrangements of the slaughter-houses would not, in any way, interfere with tbe employment of the servants of the butchers, nor could any inconvenience arise from their congregating together at such places—nor any loss from theft. All these preventive arrangements had been fully explained by Mr. Grantham, in his recent Treatise on Publlic Slaughter-houses.

The opinion of the meeting appeared to be pointedly in favonr of so desirable a measure as the establishment of Islington Market; and hopes were expressed strongly, that, by showing to the trade that their interest was so intimately connected with the measure, their co-operation would be obtained, to their own ultimate profit, as well as for the public good.

February 13.

The paper read was "On the Coal-field of South Wales," by Mr. Joshna Richardson, M. Inst. C.E. It commenced by enforcing the necessity for an unbounded supply of fuel for the export trade, the manufactures, and the domestic uses of Great Britain, and enumerating various sources from whence that supply was at present, and might be in future, obtained; giving, at the same time, the various and discordant opinions of eminent authorities, as to the presumed duration of tbat supply from the several mineral districts of which the extent was now ascertained. This was variously stated by different authorities at between two hundred years and seventeen hundred years; but Mr. Richardson ventured to assert, that, in spite of the increasing demand for home consumption, and an augmenting export trade, amounting at present to upwards of six millions of tons annually, when the coal-field of South Wales should be brought into full work, the duration of the supply was beyond calculation. The area of this coal-field alone, he estimated, from actual survey, to be one thousand and fifty-five square miles, embracing all qualities, from extremely bituminous coal to pure anthracite. The various veins, and their several thickness, were fully described, with examples of their quality, and analysis of them chemically, with their practical evaporating powers; showing that there existed sixty-four seams or veins of coal, having an aggregate thickness of one hundred and ninety feet. These veins were described to be so situated as to be easily worked by adits or levels, and by pits of slight depth; and thus the cost at the mouth of the levels varied from two shillings and twopence to three shillings and sixpence per ton—giving a mean of about two shillings and tenpence per ton. The means of transport to the ports of Cardiff, Newport, and Swansea, altbough at present inefficient, were daily improving, and enabled the coal to be shipped at about the same rates as the coal in the Tyne and the Wear.

The actual annual consumption was shown to be:—

	Tons.
In the Iron Works of South Wales,	1,500,000
In the Copper Works,	300,000
In the Tin-plate and other Works,	200,000
In Agricultural and Domestic uses,	1,000,000
In Exports,	1,500,000
Total,	4,500,000

The useful and evaporative qualities of the various veins were carefully investigated, and it was shown, in a table of relative evaporative values, tbat

1 lb. of Welsh Coal will evaporate	9	lbs. of water.
1 lb. of Newcastle and Yorkshire Coal	7½	"
1 lb. of Lancashire Coal	7	"
1 lb. of Scotch Coal	6	"

And it followed, that if

Welsh Coal was worth	20s.	per ton.
Newcastle and Yorkshire was worth	16s. 8d.	"
Lancashire "	15s. 6½d.	"
Scotch "	13s. 4d.	"

The coals of Staffordshire and Derbyshire were not taken into consideration, because they were used chiefly for the consumption by home manufactures.

From these, and other statements, and from extracts from Sir Henry De La Beche and Dr. Lyon Playfair's able Report on Steam-Coal for the Navy—which a sueeinct abstract cannot embraee—it was shown, that the Welsh coal excelled all others for steam purposes, and for almost all uses to which it was applied; and that, when all other sources of supply had diminished or had failed, the prosperity of the manufactures and the commerce of Great Britain might be maintained for ages by the coal-field of Sonth Wales.

A very animated discussion ensued, in which several eminent engineers and chemists reasoned upon the statements in the paper, and the contested questions of the evaporative powers of different fuels.

The discussion was announced to be continued at the next meeting, of Tuesday, February 20th, when "An account of the Explosion at the Eaglesbush Colliery, Neatb," by Mr. Joshna Richardson, would be read.

SOCIETY OF ARTS.

Session 95.

January 17, 1849.

On "Improvements in Electric Telegraphs, and new plans for Printing by Electricity," by E. Highton, C.E.

Perfect as telegraphs at first sight appeared, observes the anthor, when Professor Wheatstone applied tbe discovery of Œrsted to telegraphie purposes, and used the attractive power of soft iron (discovered by Arago), for releasing or guiding the mechanical operations reqnisite for the purpose of either pointing to or printing letters, still imperfections were found to exist to a very serious extent; so much so, as to render in practice many of the plans proposed useless. Previous to pointing out the imperfections alluded to, Mr. Highton made a few remarks relative to the action of electricity and magnetism generally. He then proceeded with the snbject of the paper, and considered it under the following heads:—1st, The Instruments; 2dly, Tbe Conducting Wires; 3dly, The Batteries; and 4thly, The action of Atmospheric Electricity, Lightning, the Aurora Borealis, and Electrical Fogs.

The first instrument he called attention to was the bell. The ringing of a bell at a distant point, nnder the latest improvements of Messrs. Wheatstone and Cooke, is effected by means of the attractive power developed in masses of soft iron, which causes the removal of the detent from a hammer, which then strikes out the retaining catch of a piece of clockwork mechanism, and allows a bell to be sounded. The method employed by Messrs. Highton differs from the foregoing, as regards the mechanism, in the same manner as a watch differs from a clock, a watch being capable of continuing its action in any position. The plan consists in making a spring act hy a connecting-rod on the circumference of a wheel; attached to tbis wheel is the catcb detained hy the electro-magnet armature. The removal of the armature detent is effected by electro-magnetism developed in the metal nickel. The alarum may also be rung by magneto-electricity, by merely removing the armature from a magnet. Messrs. Highton propose using tbe metal nickel as an electro-magnet in all step-by-step motions, owing to this metal producing little or no residual magnetism.

Having thus allnded to the bell, the author next proceeded to describe the first and most simple form of telegraphs; and, as an instance of the class, described the needle instruments of Messrs. Wbeatstone and Cooke. The signals with these instruments are given hy the deflection of one or more magnetic needles to the right or left. The needle is placed within a coil of wire, which surrounds it longitudinally. It is well known that the greatest amount of the power of a magnet is at its poles, and the celebrated Conlomb has given the following as a ratio of the power of a magnet. He took a magnet 27 inches long, and having tested the power at every part, he arrived at the following results, viz.—

Distance from the north pole of the magnet in inches.	Observed intensity of the magnet at these distances.
0	165
1	90
2	48
3	23
4 and 5	9
6	6

and from six inches to the centre little or no power could he ascertained.* This fact having been ascertained, it became evident that a large portion of the coil, as nsed by Messrs. Wheatstone and Cooke, was exposed only to the dead part of the magnet. Mr. Holmes, to obviate the objections to this form of magnet and coil, substituted a diamond-shaped magnet for the longitudinal magnet of Messrs. Wheatstone and Cooke: this effected a great improvement. Messrs. Highton have, however, carried their improvements still further, by introducing a horse-shoe magnet, instead of a needle—the wire, or coil, being placed near the poles only. By this arrangement, the resistance offered to the current of electricity in having to pass over tbe dead part of the magnet, as is the case in all other plans, is entirely got rid of, and the centre of oscillation and percussion are brought much nearer to the centres of gravity and motion; and hence less electric power is required, and the oscillation of the needle is at the same time removed.

The next class of instruments alluded to was of a mechanical nature, or those in which a step-by-step motion is employed, a hand being used to point on a dial to the letters of the alphabet, or to print them on paper. The evil attendant on the use of this form of telegraph, under the old mode of construction, consists in the

* To illustrate this fact, a magnet was placed by the author under a sheet of paper, and iron or nickel filings having been sprinkled over the paper, they immediately arranged themselves round the two poles, showing the lines of the magnetic curves, and tbe intensity of the magnet at the poles.

instrument not having any self-adjusting principle, so that when one instrument in a series, slips or misses a letter, the error is propagated throughout the message, unless the whole of the instruments are re-arranged by the attendants. Messrs. Highton having observed this defect, have adopted the following plan for eradicating the evil, viz., by placing a second electro-magnet, or other magnetic apparatus, to any of the usual escapements; so that, by sending a current through it, the pallets can be detached from the escape-wheels of all the instruments, and thus the whole of the incomplete revolution of all the hands, discs, or wheels is made at one bound, and thus the time required for the transmission of a message is halved, and absolute certainty given to this class of instruments.

The fourth class of instruments alluded to were direct letter-showing telegraphs. All previous plans, in order to expose instantly to the eye any one of twenty-six letters, required no less than twenty-six wires. In Messrs. Highton's instruments, *three* line wires only are requisite. The letters are shown by the single or combined motion of three screens. No weights or wheels, or similar description of mechanism, is employed, but each screen can, by motion to the right or left, be made to assume any one of three positions; and thus, by the combination of three screens, any of twenty-seven relatively different positions can be produced.

The fifth class of instruments described, the author has called the Perænode, from the Greek word περαίνω, *to complete*, it being an instrument by means of which a secondary circuit can be completed, and a secondary current of electricity brought into action with the greatest precision. One form of this instrument consists of a series of bar and electro-magnets, and is used by the inventor in connection with his printing telegraphs, in order to prevent the necessity of sending powerful currents of electricity down a line, when great mechanical effects are required of the telegraph at different stations.

Mr. Highton then proceeded to describe the application of this instrument in connection with the above property of *three* line wires, and showed how, with three wires only, any one of twenty-six letters could instantly be printed at distant stations, and that as rapidly as the corresponding keys could be played upon. The arrangement of the mechanism in these printing telegraphs is such, that no error or inaction of any of the parts of the instruments can entail subsequent errors in the message.

Mr. Highton described six different kinds of printing telegraphs, suited respectively to one, two, or three line wires, and combining several of the above improvements.

January 24.

"On the History of Steam Navigation," by Bennett Woodcroft, Esq.—Steam navigation, in its present practical state, owes its origin and progress to the improvements recently made in the steam-engine in this country.

The employment of animal power in the propulsion of vessels, by means of paddle-wheels, is of very ancient date; and the substitution of the steam-engine for the same purpose was suggested as soon as the steam-engine was rendered effective in pumping water from mines, long before it was found capable, from its then imperfect state, of propelling a vessel advantageously.

In 1472, Robert Valturius gave a view of two galleys moved by wheels instead of oars. In 1543, Blasco de Geray, a Spanish sea-captain, is said to have exhibited an engine by which vessels or ships of large size could be propelled. In 1785, Joseph Bramah, the inventor of the hydraulic press, obtained a patent under the following title, "His new-invented Hydrostatical Machine," and a boiler on a more peculiar principle than any yet made known to the public; and one of the inventions described in his specification, is a mode of propelling vessels by the improved rotatory engine therein described and claimed, which will act as a pump by means of a paddle-wheel, or what may be called a screw-propeller. On January 5th, 1769, James Watt obtained a patent for improvements in the steam-engine, one of which was for causing the steam to act above as well as below the piston; and this was called the double "impulse," or double-acting engine. This was the first great improvement in the steam-engine, and rendered it applicable to propelling vessels.

In 1785, a patent was granted to William Symington for "his new-invented steam-engine on principles entirely new;" and in 1787, Patrick Miller published a pamphlet on the subject of propelling boats by paddle-wheels turned by men. The vessels to which they were applied were called triple vessels, the deck being constructed so as to cover three small vessels, the two paddle-wheels being fixed in the space between them. The first boat in which the steam-engine was used for the purpose of propelling was constructed by Mr. Symington, at the suggestion of Mr. Taylor, a person to whom Mr. Miller had made known his views of the possibility of propelling vessels by means of paddle-wheels. From the experience which Mr. Symington gained in the construction of Mr. Miller's boat, and the circumstance that, in 1789, the crank had been discovered by Pickard, and at this time the double-acting cylinder and crank were being used for stationary engines, he abandoned his own old engine, and obtained a patent for applying a double-acting reciprocating engine to a boat, and for placing his crank on the axis of the paddle-wheel. This was a very important discovery.

The name of the vessel in which Symington combined the double-acting engine of Watt, the crank and fly-wheel of Pickard, and the improved wheel of Miller, was the *Charlotte Dundas*.

This combination of machinery constituted the system of steam navigation now used, and this vessel was the parent steam-boat of its race. Mr. Fulton, the American engineer, and Mr. Bell, the Scotch engineer, were on board the *Charlotte Dundas*, and acquired a knowledge of the machinery used. Mr. Fulton subsequently introduced this system of propelling into America, and he was the first person to establish steam-boats for practical purposes.

Mr. Bell was the first person in Europe who established practical steam-boats.

From the establishment of practical steam navigation in 1807, to the year 1837, the paddle-wheel was the only instrument used to react against the water; but in the latter year an instrument, now generally termed a screw-propeller, was practically introduced by Captain Ericsson.

Although almost innumerable modes of propelling vessels have from time to time been suggested and patented, the only instruments that have hitherto been found of practical benefit are the paddle-wheel and the screw-propeller, each under various modifications. The varieties of the paddle-wheel are known by the names of the common paddle-wheel, as improved by Miller; the Morgan paddle-wheel, invented by Mr. E. Galloway; and the split paddle-wheel, invented by Mr. Field. The varieties of the screw-propeller are portions of a uniform pitch-screw, as patented by Captain Ericsson; and the increasing pitch-screw, as patented by Mr. Woodcroft.

In following out the principle of annually collecting and exhibiting the pictures and studies of some one eminent living artist, as commenced last year with Mr. Mulready's works, the society this year proposes to collect Mr. Etty's productions. We wish them good speed in their project, as the plan at once extends and advances the British School, and affords honourable testimony to the merits of our most distinguished men.

January 30.

"On the Photometer," by A. Claudet, Esq.—The art of Photography, observes the author, is founded on the property with which light is endowed, viz., of producing a photographic effect when it strikes upon certain chemical compounds. The effect being in proportion to the intensity of the light during a given space of time, it is necessary for the success of the operation to be able to ascertain the exact power of the light at any particular moment; and the only means of so doing hitherto possessed by the photographer, is the effect it produces upon the eye. A few only of the rays which emanate from the sun are capable of producing the photographic image; and if it were possible to admit into a room only the rays which are endowed with the power of effecting the photogenic preparation, the objects in the room would not be visible to the eye, as the room would appear to be plunged in darkness, while the objects in it would reflect some invisible rays which are capable of producing, on the chemically-prepared surface, an effect which is the cause of the photographic picture.

This fact the author illustrated by a series of specimens, in which the effects of rays of light reflected from the various colours used on porcelain and other surfaces were exhibited.

The property of absorption possessed by red, orange, yellow, and green glass, and the power of admitting through blue glass nearly all the photogenic rays which are not luminous, are known to photographers. By improvements which have taken place since the discovery of the art by Daguerre, photographers of the present time are enabled to employ a very soft light, and place their sitters in the shade.

The action of the blue and yellow rays was shown by covering a large print, one-half with dark blue, and the other half with yellow glass: that portion of the print which was perfectly visible to the eye through the yellow glass was rendered invisible by the action of the ray on the photographic plate, while the ray reflected from the blue glass, which, to the eye, entirely obscured the picture, was rendered perfectly clear and distinct on the Daguerreotype plate; for this reason, when the operation was long, and it was necessary, in taking portraits, to submit the sitter to a very strong light, and even to the sunshine itself, operating-rooms were glazed with blue glass, which protected the eyes from the glare of light, but this has been abandoned. Specimens intended to show that the luminous and photogenic rays are not the same were also exhibited.

Some philosophers are of opinion that the photogenic rays are as independent of the light as heat is, although they are sent forth from the same source, travel together at the same velocity, and are subject to the same laws of reflection, refraction, and polarization. The actinic or photogenic rays are situated at the most refrangible part of the prismatic spectrum, and are thus refracted to the same degree as the blue, indigo, or violet rays. A series of experiments on various colours obtained by artificial means were next exhibited, the whole tending to prove that the atmosphere of London, with its smoke and fog, is too often, for the photographer, like the ray from the yellow glass.

As the result of the photographic operation depends on the intensity of the actinic rays, and also upon the degree of the sensitiveness of the chemical preparation, Mr. Claudet has constructed an apparatus, which is not only capable of measuring photogenic light, but of testing the sensitiveness of the chemical preparations of the Daguerreotype plate. This instrument consists of an inclined plane, capable of adjustment to any angle. Upon this incline a frame is made to descend, having upon it a series of geometrically-proportioned apertures for the passage of the light in descending the incline. The apertures pass over the photographic plate, which is covered with a second plate, having a series of circular holes cut in it, coinciding with the proportionate apertures; and by the number of holes fixed on the plate by the passage of the frame down the incline, the power of the actinic or photographic ray is registered. The number of different effects capable of being registered by this instrument is 8192. In illustration of the action of the photographic ray on finely polished surfaces, Mr. Claudet exhibited a series of photographic specimens which had been impressed without the use of mercury; and at the conclusion of the paper, Mr. Robert Hunt, in reply to a question by Mr. Webster, stated, that although it is necessary, to insure rapidity of action, that some chemical compound, as iodide or brom-iodide of silver, should be employed, yet we have distinct evidence that every body in nature is liable to change under the influence of sunshine. This is easily capable of proof. If a perforated screen is placed upon a glass, metal, or stone plate, and it be then exposed for an hour to sunshine, all those parts which are uncovered will be found to be in a different condition from those protected by

the screen; and if the tablet be submitted to the vapour of mercury, or even if we breathe over it, a deposit will take place upon some parts, and not at all on others, leaving a distinct outline of the perforated image. If a plate covered with resin is employed, that portion of the resin which is exposed to solar radiation is rendered more soluble than the other covered portion, and may be with greater facility dissolved off. In any of these instances, however, we may also convince ourselves that all bodies have the power of restoring themselves in the dark to that condition in which they were previously to the disturbing influence of the sunshine,—realizing the hypothesis of Niepce, that the hours of darkness are as necessary to the inorganic world as night is to the organic creation.

Referring to the term actinism, which Mr. Hunt explained he had adopted after Sir John Herschel had proposed to class all photographic experiments under the term of actino-chemistry, he proceeded to state, that every day brought additional evidence that light and this actinism, the chemical agent which always accompanies it, are not identical; that where we have indeed the most light, there we have the least actinic power. By employing an absorbent yellow medium, and allowing the prismatic spectrum to pass through it, and fall upon some highly sensitive photographic preparation, on which at the same time the full light of the sun is reflected from a mirror, a space is preserved over the line marked by the coloured spectrum absolutely free from change; while every other part will be blackened, this line will remain white, thus showing that light is in direct antagonism to the actinic solar radiations.

Mr. T. B. Jordan gave a short account of Mr. Cochran's machine for sawing timbers with curved and bevelled faces, and a working model was exhibited to the meeting.

ROYAL INSTITUTION.

January 19.

W. R. Hamilton, Esq., V.P., in the Chair.

The Reverend the Master of Trinity College, Cambridge, "On the Idea of Polarity."

Polarity is a new idea, which is not yet clearly held by most persons.

1. It occurs first in Gilbert (De Magn., lib. i. c. 3), who compares the poles of the magnet to the poles of the earth,—"being certain determinate points, the termini of the motions and effects, the limits and governors, of several actions and virtues." "Yet," he adds, "this form does not proceed from a mathematical point, but from all contiguous parts according to their contiguity." From the magnet, then, came the whole philosophy of polarity yet acquired; and there is probably much more to be derived from the same source. The position of the magnetic needle on the earth's surface was first explained by supposing that it tended to two magnetic poles; but, as observations were multiplied, it was found that this supposition could not explain the facts. Four poles were assumed by Hansteen (Magnetismus der Erde, 1819); but Gauss (Taylor's Scien. Mem., vol ii. arts. v. ix.), investigating the result as a mere effect of indefinite magnetic elements, showed that there were only two points which could be called poles; and the common notion of *poles* melted into *polarity*.

2. Thirty years ago, the theory of Malus—which, assuming light as a material emission, invested its particles with poles—was for a while satisfactorily used to explain the phenomena of what was called *polarization of light*. Though this was a clumsy and improbable theory, *it explained the facts;* and a clumsy and improbable theory which does this, is a step to a theory which does it better. Philosophers soon seized the essential point in this hypothesis: viz., that it implied opposite properties in opposite directions,—calling those *opposite directions* which are at right angles to each other; and the *opposite properties*, the property of being transmissible or non-transmissible, reflexible or non-reflexible, by the glass or crystal. As the facts of the polarization of light became better known, the notion of particles with poles became more untenable, and the notion of transverse vibrations was adopted. Here, also, the notion of *poles* melts away into the idea of *polarity*.

3. In *Franklinic* electricity, the attractions and repulsions were well explained by Coulomb, who referred them, not to fixed poles, but to fluids having polar relations, positive and negative.

4. In *galvanic* electricity, the analysis and synthesis which took place in the battery have been proved by Dr. Faraday to be due, not to any action of definite points, as poles, but to be extended over the whole circuit. Dr. Faraday's substitution of the terms *anode* and *cathode* (the doors by which the current passes up and down) for the term *poles*, is itself an instance of the notion of *poles* vanishing as the idea of *polarity* became clearer. It was also shown that, galvanic electricity being Franklinic electricity in another shape, a relation was established between chemical and electrical polarity.

5. *Electro-magnetism.*—Œrsted discovered that the lines of galvanic and magnetic polarity arranged themselves at right angles to each other; and thus we had still more distinctly two *connected polarities*. But this was not all. The needle not only tended to stand transversely to the galvanic current, but it did this by turning in a particular way under given circumstances. There was more, therefore, here than in the polarization of light, where all that was requisite for certain phenomena was, that the plane of polarization should be perpendicular to a certain plane, whether it became so by turning to the right or to the left. These kinds of polarity may be distinguished by calling the one *current*, the other *axial*, polarity. The fact of current polarities necessarily calls for a mechanical hypothesis of the connection. And the general facts of electro-magnetism may be derived from supposing the magnet to consist of parallel transversely-circulating galvanic currents, such currents attracting each other.

6. *Magneto-Electricity.*—By the above hypothesis magnetism could be derived from galvanism, and this was verified in part. What! could galvanism, conversely, be derived from magnetism? Dr. Faraday discovered that magnetism, not permanently existing, but when beginning or ceasing to be, puts electricity in action. If a magnet be conceived as consisting of transverse galvanic currents, then when those currents are put in motion, there is, as it were, a re-action (like the recoil of a gun) producing a galvanic current in the opposite direction. When the currents are stopped, there is, as it were, a momentum producing a galvanic current in the same direction (as the bullet when stopped tends to drive the obstacle forward). The mechanical terms "re-action" and "momentum" are here advisedly used, to show that it is necessary to have recourse to images which may be only transitory hypotheses, to be modified or even rejected hereafter. But in this magneto-electric induction, we have a kind of mechanical effect produced by the machinery which had previously been used to express galvanic polarity—namely, a current. The distinction of rest and motion, which had already given origin to the term *current*, appears in a new form in the relation of galvanism and magnetism. Here the machinery which had already been devised, appears to receive a sort of confirmation.

7. *Electro-tonic State.*—Transverse electricity. The philosophical caution of Dr. Faraday in declining to hazard any conjecture as to what actual condition this idea embodies—until facts shall have clearly disclosed it—contrasts instructively with the rashness with which men of great name in Europe (for example, Schelling and Hegel) have built up systems of arbitrary and baseless polar antitheses from their own imaginations. The idea of polarity, like all other ideas which enter into science, can, to any purpose, be suggested, evolved, defined, generalized only by attention to facts—by practical, skilful, ingenious prosecution of experiment.

Though we have many kinds of polarity, and many connections among them, we are as yet unable to see the whole bearing of these connections. It is as if we had advanced, scene by scene, into the middle of a drama, and had observed the sympathies and antipathies, the relations and derivations of the characters, and still had to wait for the *denouement*, in which all these find their places and their reasons.

8. *Chemical Polarity* now enters as a new character in this drama. Chemical speculation leads us to attempt to conceive in what manner the elements of bodies are associated. If two atoms, A B, adhere, so as to form one particle, the line A B, which joins their centres, must have some position in space. It may be looked upon as an axis, the poles of which are A and B. Crystallization plainly depends on the position of such axis. Chemical polarity appears in the form of galvanic polarity: it appears, also, in the form of crystallization. And the connection between these polarities, which was *à priori* probable, Professor Plücker and Dr. Faraday have recently established by experiment—namely, by discovering that the magnetic force determines the position of crystals and its influence. But this is an *axial* polarity (like that of the polarization of light), not a *current* polarity (like that of the magnet under the galvanic line).

9. Here then we have, as it were, a closed cycle of polarities. Chemical polarity is galvanism—galvanism, in a transverse direction, is magnetism—magnetism, in a transverse direction, affects crystallization. Crystallization is a result of chemical polarity. But this cycle is not really complete; for here the term chemical polarity is used in two different senses. Chemical polarity, as identical with *galvanism*, is the polarity of *chemical analysis and synthesis*. Chemical polarity, as connected with crystallization, is the polarity of *permanent chemical composition* or *systasis*. And this implies relation of space. Now, the relation of chemical *systasis* and *synthesis*, i.e. of the permanent structure, and the transient or progressive act of the dissolution or composition of that structure, is obscure, and not yet an element of any theory. Therefore, it is not wonderful that theories do not afford the means of connecting the members of this cycle of polarities. Consequently, whoever should devise any hypothesis of the construction of bodies, which expressed the crystalline structure as dependent on chemical force becoming, in analysis, a galvanic current, would render a service to science, however inadequate his hypothesis might be.

10. In the parallel columns of the following Table of Polarities are presented, first, the *antithesis*, which causes the polarity; and secondly, the *hypothesis*, which has been framed to explain it. Provisional and transitory as may be the character of many of these hypotheses, they are not the less indispensable in the progress of scientific investigation. That no obstacle is presented by a provisional hypothesis to the progress of truth, is shown by the explanation of a fact or law given on one hypothesis becoming afterwards capable of being translated into the language of another hypothesis. Thus, Faraday's hypothesis of the production of electrical induction by curved lines of contiguous polar particles in the intervening dielectric, does not disturb Coulomb's calculations of the effect of induction, as represented by the result of the attraction and expulsion of the two electric fluids acting at a distance through all intervening bodies, as was shown by a diagram.

Polarities.	Antithesis.	Hypothesis.
Polarization of light	Transmission and non-transmission	(Particles with poles, or better) transverse vibrations.
Dipolarization by crystals	Complementary colours	Transverse vibrations.
Magnetism (iron, &c.)	Attraction and repulsion	Attraction and repulsion at a distance (of solid particles, or better) of two opposite fluids.
Terrestrial magnetism	Needle points N. and S. nearly	(Two poles, four poles, or better) the earth a mass of polar elements.
Electricity (induction)	Attraction and repulsion	Two opposite fluids, particles attracting and repelling at a distance, or action through polar contiguous particles (Faraday).

Polarities.	Antithesis.	Hypothesis.
Chemical polarity, composition or syntasis	Base and acid	
Chemical polarity, analysis and synthesis	Anion and cathion	Opposite motion of anion and cathion.
Galvanism	Zinc and copper under action of acid	Current of fluid in the wire.
Electro-magnetism	Magnet turns right or left by galvanic current	The magnet is composed of transverse circulating galvanic currents.
Electro-magnetic induction	Magnetism started or stopped gives galvanic current opposite ways.	Galvanic current has momentum.
Electro-tonic state?		
Diamagnetism (bismuth, &c.)	Repulsion and attraction	Induction like magnetism (F. 2429). Two fluids?
Magne-crystallization	Crystalline axis directed by the magnetic line	Line of anion and cathion directed by the magnetic line?
Crystalline form	Opposite faces making the same definite angle with an axis	Elementary particles definitely arranged in space according to anion and cathion?
Dipolarization by crystals	Complementary colours	Transverse vibrations determined by crystalline axis.
Circular polarization affected by galvanic current	Deviation of plane of polarization to right and left	Circular luminiferous vibrations connected with galvanic current?
Polarization of heat	Transmission and non-transmission	Transverse vibrations?

MONTHLY NOTES.

Scoop-Wheel Draining.—When travelling in England lately, we observed that the scoop-wheel system of draining had obtained a trial in the north of Lancashire, upon the estate of Richard Gillow, Esq. Some dozen miles or so north of Lancaster, is a large tract of low-lying mossy ground, situated between the villages of Yealand Conyers and Silverdale, and on the edge of the bay of Morecambe. Being perfectly level, and hemmed in on each side by high ground, a change in the position of the channel of the river Kent has edged up the level on the outlet side towards the sea, and the water draining from a tarn or lake at the higher end of the ground, together with the surface water of the hills, is prevented from escaping. The deluge of the surface water has been considerably mitigated, by collecting it into a stream, and carrying it over the elevated ground in a timber trunk; whilst a scoop-wheel, driven by a steam-engine, takes off the drainage water from the moss, elevating it about six feet, and discharging it down a water-course formed for the purpose. The plan has only, so far, been partially successful; but the great expanse of farm-land, at one time totally covered, has now emerged, and it is supposed a few weeks' work of the scoop per year will keep it dry for the future.

Surface-Clearer for Plumber's Work.—Mr. Bryce of Dunlop Street has shown us a simple apparatus, for clearing away the oxidized matter from the surface of lead or zinc, where junctions for pipes are to be effected. It consists simply of a common pair of compasses, with a small adjustable tubular leg, carrying a cutter, or scraper, at its lower end. By setting the compass point upon the centre of the intended position of the pipe, and turning it round, the scraper clears off a ring of the size required for the pipe.

Webster's Hand-Pipe and Tile Machine.—We have lately been favoured with a sketch of a clever machine of this class, invented by Mr. Webster, the eminent draining engineer of Hounsdown, Southampton. In construction, it is simplicity itself, being little more than a long rectangular box, with shifting lids at each end, for receiving the clay. The forcing apparatus is driven by a lever-wheel on a pinion shaft, which drives a large spur-wheel, directly connected to the piston arrangement. The machine is driven in each direction alternately, the fresh clay being put in at one end of the box, whilst the newly-formed tiles or pipes are issuing from the other. The opening and closing of the end-receiving lids of the clay chamber are managed in the simplest manner, by attaching a chain to the upper driving pinion shaft, which chain is again connected to the lids, so that, as the piston travels to one end, in forcing out the clay, the lid of the contrary end is elevated by the taking up of the chain upon the shaft. The entire apparatus weighs about 8 cwt., and is entirely of iron. It is stated to be capable of making 500,000 tiles per annum, worked by one man. One or both ends may be used as a pug-mill, to free the clay from stones or roots, and, at a pinch, it may be used as a crusher for the steamed roots of the farm-yard.

Mr. Maudslay's Improved Cannon.—We have heard of many schemes for sponging and loading guns at the breech, but none appear to have stood the test of practice, and certainly none which we have seen are at all equal to the plan proposed by Mr. Maudslay, the eminent marine-engineer. In his gun, the bore goes right through from muzzle to breech, and a square aperture is formed in the breech, at right angles to the axis of the bore. This opening has a sliding-piece exactly fitting it, which can be drawn in or out by a toothed pinion, which is set upon a stud, carried by a projection on the gun's breech, and works into rack-teeth on the tail of the sliding-piece. When the gun is to be loaded or sponged, the slide is withdrawn, and when returned, the breech is just as efficient as if it were perfectly solid. Greater rapidity in firing will thus be gained, and the gunners will suffer less from exposure to the enemy's fire.

Joyce's River Boats.—We have frequently referred with pleasure to the progress made by Messrs. Joyce of Greenwich, in high-pressure oscillating engines for river use, and we have now to chronicle the performance of one of the same class on the low-pressure principle—the "Emmet," which has been built by this firm, to run in concert with the well-known boats of the A B C Company, plying above bridge as the "halfpenny boats." The "Emmet" is 131 feet long, and 13 feet beam, with cylinders 26 inches diameter, and 30 inches stroke. The boiler is tubular, and is constructed of $\frac{5}{8}$ inch plates. In an experimental trip to Gravesend and back, she realized a speed of $16\frac{3}{4}$ miles through the water. In testing her against the "Topaz," which is considered one of the best Gravesend boats, she gave the latter two miles' start, and then overtook her near Greenhithe, beating her by near half-an-hour. On another occasion she beat the "Brunswick," one of the most powerful of the Gravesend boats. Her average pressure of steam is 11.71 lbs.; average vacuum, 24.84 inches of mercury; making together, 24.13 lbs. upon the piston. At this pressure, her indicated power is 177 horses, speed being 46 strokes per minute. We shall keep a look-out for her future performances, and note the position she keeps.

Preservation of Timber.—An incident occurred some few years ago, in taking down a part of the ancient chateau of the Roque d'Ondres, which shows how much may be made by carefully noting accidental matters. In removing the extremities of the oak girders set in the walls, it was found that, although they had been up for upwards of six hundred years, they were perfectly sound. The secret of this was, that they were enveloped in plates of cork—at least the cork was there, and the timber was sound. Again, in pulling down an old Benedictine church at Bayonne, the rotten fir girders were in like manner wrapped round with cork at their bearings, and these parts were perfectly sound. We give the facts, as matters worthy of further inquiry.

Process for Splitting Paper.—A working man in London, of the name of Baldwin, has lately discovered and perfected a process, whereby he is able to split the thinnest sheet of paper into two equal films with the greatest accuracy. The Directors of the Bank of England, hearing of his proficiency in the difficult operation, sent for him to the Bank to test the truth of his assertions. He was furnished with one of the old thin notes for the purpose, which he took away with him, and returned the next day, beautifully split, the impression on each half being as good as on the original full thickness. The inventor is, we believe, a print-mouuter; he was first led to try the experiment, from a wish to obtain an engraving from one of the illustrated papers, without the letterpress on the other side showing through. Amongst the propositions which have since been hazarded on the subject, one is to pass the paper through two rollers of glass or amber, strongly excited by friction, or other means, so that a strong attraction of cohesion is produced. If great pressure is used in passing the sheet through, each roller will carry off one-half thickness of it, making a perfect split. Whether this is the inventor's plan or not, is not yet known, nor is it certain that this does really answer.

Electro-Magnetism as a Moving Power.—Professor Œrsted, the well-known discoverer of electro-magnetism, has recently been engaged in a close investigation of the laws which regulate diamagnetic phenomena; and in connection with these researches he has noted some results which bear strongly on the question of the employment of electro-magnetism as a motive power. The Professor finds that, if a magnetic power equal to 100 is produced by one pair of galvanic elements, 144 only is produced by two pairs; that no sensible increase of power is produced by three pairs of similar plates; and that eight or sixteen pairs only give a power about equal to twice the effect of a single pair. When the armature was $\frac{1}{100}$ of an inch from the electro-magnet, the power was 0.178 of that produced by contact; but sixteen elements then produced four times the effect of a single pair. It appears to us that these results exhibit the impracticability of employing electricity as a motive power within the limits of any ordinary economy. The result of a trial shortly to be made on two large electro-magnetic machines, now nearly ready, in the metropolis, will determine the question more satisfactorily for superior forces.

ENGLISH PATENTS.

Sealed from 20th January, 1849, to 15th February, 1849.

William Boggett, St. Martin's-lane, Middlesex, manufacturer,—"Improvements in methods and machinery for obtaining and applying motive power."—January 20th.

Henry Bernoulli Barlow, Manchester,—"Improvements in the manufacture of pile-cut fabrics, and in machinery or apparatus applicable thereto."—(Communication.)—20th.

Samuel Brown, the younger, Lambeth, Surrey, engineer,—"Improved apparatuses for measuring and registering the flow of liquids and of substances in a running state, which apparatuses are in part also applicable to motive purposes."—20th.

Henry Needham, Vine-street, Piccadilly, Westminster, gun-maker,—"Certain improvements in fire-arms."—20th.

Thomas Robinson, Leeds, flax-dresser,—"Improvements in machinery for breaking, scratching, cutting, heckling, dressing, combing, carding, drawing, roving, and spinning flax, hemp, tow, wool, silk, and other fibrous substances, and in uniting fibrous substances."—23d.

Charles de Bergue, Arthur-street West, London, engineer,—"Improvements in steam-engines, in pumps, and in springs for railway and other purposes."—23d.

Edward Slaughter, Avonside Iron Works, Bristol, engineer,—"Improvements in marine steam-engines."—23d.

Rees Reece, London, chemist,—"Improvements in heating peat, and obtaining products therefrom."—24th.

Charles Henry Paris, Paris, France,—"Improvements in preventing the oxidation of iron."—(Communication.)—23d.

William Henry Barlow, Derby,—"Improvements in the construction of permanent ways for railways."—23d.

Richard Johnson, Blackburn, Lancashire, gentleman,—"Certain improvements in the manufacture of malted grain, and in vinous fermentation; also, improvements in brewing, and in the machinery or apparatus connected with the above or similar processes."—23d.

Wakefield Pim, Borough of Kingston-upon-Hull, engine and boiler maker,—"Certain improvements in propelling ships or vessels."—25th.

Robert Shaw, Portlaw, Waterford, cotton-spinner, and Samuel Fletcher Cottam, Manchester, machinist,—"Certain improvements in machinery for preparing spinning and doubling cotton, wool, flax, silk, and similar fibrous materials."—25th.

John Talbot Tyler, of the firm of Ashmead and Tyler, Mount-street, Grosvenor-square, batters,—"Certain improvements in hats, caps, and hat-cases."—25th.

Pierre Frederic Gougy, Paris, gentleman,—"Improvements in apparatus and machinery for lifting and moving heavy bodies, and for raising and displacing fluids."—27th.

Richard Archibald Brooman, Patent Office, Fleet-street, London, patent agent,—"Certain improvements in the manufacture of artificial limbs."—(Communication.)—27th.

James Green Gibson, Ardwicke, near Manchester, machinist,—"Certain improvements in machines used for preparing to be spun and spinning cotton and other fibrous substances, and for preparing to be woven and weaving such substances when spun."—27th.

Ewald Riepe, Finsbury-square, Middlesex, merchant,—"Improvements in the manufacture of soap."—30th.

Alexander Wilkins, brewer, and William Stacey, engineer, both of Bradford, Wilts,—"A certain improvement or improvements applicable to heating and boiling of liquids of any kind or description."—30th.

Lemuel Wellman Wright, Chalford, Gloucester, civil engineer,—"Certain improvements in preparing various fibrous substances for spinniug, and in machinery and apparatus connected therewith."—30th.

William Kenworthy, Blackburn, Lancaster, cotton-spinner,—"Certain improvements in power-looms for weaving."—31st.

Henry Bessemer, Baxter-house, Old St. Pancras-road, Middlesex, engineer,—"Certain improvements in the manufacture of glass, and in apparatus connected therewith."—31st.

Jean Adolphe Carteron, Paris, France, now of the Haymarket, Middlesex, chemist,—"Certain improvements in dyeing."—February 5th.

John Browne, late of Bond-street, but now of Great Portland-street, Middlesex, gentleman,—"Improvements in constructing and rigging vessels, and improvements in atmospheric and other railways."—6th.

Edmund George Pinchbeck, Fleet-street, London,—"Improvements in certain parts of steam-engines."—6th.

Thomas Snowdon, Noel-street, Middlesex, engineer,—"Improvements in machinery for moulding and pressing artificial fuel and bricks."—6th.

Joseph Harrison, Blackburn, Lancaster, machine-maker, and William Harrison, of the same place, cotton manufacturer, and John Oddie, of the same place, manager,—"Certain improvements in and applicable to looms for weaving."—6th.

Henry Fisber, Upholland, Lancaster, gentleman,—"Improvements in coke ovens, and in machincry and apparatus for working the same or connected therewith, and a mode or modes of applying certain portions of coke, or the residual products of coke, to heating and lighting."—8tb.

Lawrence Hill, jun., Motherwell Iron Works, near Hamilton, Lanarkshire, civil engineer,—"Improvements in the manufacture of iron, and in tbe machinery for producing the same."—8th.

Heury Headley Parish, Eaton-place, Middlesex, Esq.,—"Improvements in safety and other lamps, and in gas-burners."—8th.

Richard Pannell Forlong, Bristol, button manufacturer,—"Improvements in castors for furniture."—8th.

William Willcocks Sleigh, Stamford Brook House, Chiswick, Middlesex, doctor of medicine,—"A means for preventing injury to persons and property from the sudden stoppage of railway carriages."—8th.

James Webster, Basford, Nottingham, engineer,—"Certain improvements in apparatus for manufacturing gas."—8th.

John Taylor, Parliament-street, Westminster, architect,—"An improved mode of constructing and fencing walls."—8th.

Joseph Barnes, Church, Lancaster,—"An improved apparatus for bleaching, dyeing, cleaning, and steaming animal or vegetable fibrous substances, either in a raw or manufactured state."—8th.

Robert Brown, Sadlers'-wells, Middlesex, engineer,—"Improvements in machinery for perforating, sewing, stitching, pegging, and riveting."—8th.

Thomas Charles Clarkson, Bennet-street, Southwark, manufacturer,—"Improvements in the manufacture and application of leather, and of certain vegetable substances to he used in combination with leather, India-rubber, cauvas, silk, cotton, wool, and other fibrous substances."—8th.

William Tooth, Broad-street, Lambeth, engineer,—"Improvements in water-closets and in chimney-pieces, in machinery for the preparation of clays and other materials, and in the manufacture of earthenware articles."—8th.

John Gihlett, Trowbridge, Wilts, gentleman,—"Improvements in the manufacture of woollen cloth."—10th.

George Edmond Donisthorpe, Leeds, manufacturer, and James Milnes, Bradford, York,—"Improvements in apparatus used for stopping steam-engines and other first movers."—12th.

Jarvis Palmer, Camberwell, Surrey, merchant,—"Improvements in matches, lighters, or similar articles, for igniting combustible bodies, in the mode or modes of manufacturing the same, and in machinery applicable therein; also, in match and other boxes, and in machinery for manufacturing the same."—12th.

William Harris, Battersea, Surrey, shoemaker,—"A new or improved mode of preparing leather."—12tb.

William Brewer, Malcolm-place, Clapham, Surrey, and John Smitb, Southville, South Lambeth, Surrey, manufacturers,—"Certain improvements in the manufacture of paper and card-board, and in producing watermarks thereon, and also in apparatus and machinery to he used for such purposes."—12th.

Christopher Nickells, York-road, Lambeth,—"Improvements in the manufacture of woollen and other fabrics."—12th.

Edward Newton, Chancery-lane, civil engineer,—"Improvements in engines, or apparatus principally designed for pumping water."—12th.

Matthew Townsend, Leicester, framework-knitter, and David Moulden, of the same place, framework-knitter,—"Improvements in machinery for the manufacture of looped fabrics."—13th.

Edward Newton, Chancery-lane, civil engineer,—"Improvements in machinery for hulling and polishing rice and other grain, or seeds."—(Communication.)—13th.

Edward Lord, Todmorden, Lancaster, machinist,—"Certain improvements in machinery, or apparatus applicable to the preparation of cotton and other fibrous substances."—13th.

Achille Chandois, Faubourg du Temple, Paris, manufacturing chemist,—"Improvements in extracting and preparing the colouring matter from orchil."—14th.

William Chambers Day, Birmingham, Warwick, iron-founder and weighing-machine manufacturer,—"Improvements in machinery for weighing."—14th.

Hugh Lee Pattinson, Washington House, Gateshead, Durham, chemical manufacturer,—"Improvements in manufacturing a certain compound or certain compounds of lead, and the application of a certain compound or certain compounds of lead to various useful purposes."—14tb.

Richard Ford Sturges, Birmingham, Warwick, Britannia-ware manufacturer,—"Improvements in the manufacture of candlesticks and lamp pillars."—14th.

John Erwood, Hoxton, Middlesex, paper-banging manufacturer,—"Improvements in tbe manufacture of paper hangings."—15th.

IRISH PATENTS.

Sealed from 20th December, 1848, to 20th January, 1849.

Duncan Mackenzie, Goodman's Fields, Middlesex, manufacturer,—"Certain improvements in jacquard machinery, for figuring fabrics and tissues generally, and apparatus for transmission of designs to the said jacquard machinery, parts of which are applicable to playing musical instruments, composing printing types, and other like purposes."—(Communication.)—December 22d.

Bartbolomew Beniowski, Bow-street, Covent-garden, Middlesex, major in the late Polish army,—"Certain improvements in the apparatus for and process of printing."—January 3d.

Joseph Simpson, Manchester, civil engineer, and James Alfred Sbipton, of the same place, engineer,—"Certain improvements in steam-engines."—5th.

Charles Green, Birmingham, Warwick, patent brass tube manufacturer, and James Newman, Birmingham, manufacturer,—"Improvements in the manufacture of a part or parts of railway wheels."—5th.

Carey M'Clellan, Larch Mount, Londonderry,—"An improved corn mill."—10th.

William Edwards Staite, Lombard-street, London, gentleman,—"Certain improvements in lighting, and in the apparatus used therein, parts of which are applicable to other useful purposes."—12th.

William Young, of the firm of Henry Bannerman and Sons, Manchester, Lancaster, merchant,—"Certain improvements in machinery or apparatus for winding, balling, or spooling thread, yarn, or other fibrous materials."—12th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 19th Jan. 1849, to 15th Feb. 1849.

Jan. 19th,	No. 1737.	William Hattersley, Ratcliffe Highway.East,—"Passengers' signal light."
20th,	1738.	Josh. Tayler and Son, Warwick-lane,—"Improved ball-cock."
—	1739.	H. I. Nicoll and D. Nicoll, Regent-street,—"Coats."
—	1740.	Edward Frisby, Marylebone-street,—"Paragon boot-heel."
22d,	1741.	Thomas Craddock, Birmingham,—"Pressure guage."
—	1742.	William K. Harvey, Blurton,—"Apparatus for cleaning potter's materials from particles of iron."
23d,	1743.	T. H. Busbridge and G. F. Busbridge, East Malling Mills, Kent,—"Dandy rollers for paper-making."
—	1744.	James Tasker, Liverpool,—"Anti-collision signal lamp for shipping and boats."
—	1745.	John Hartley, tbe Mills, Otley, Yorkshire,—"Improved mill."
25th,	1747.	M'Adam'Brothers & Co., Soho Foundry, Belfast,—"Eccentric tappets for steam-engines."
—	1748.	John Hynam, 6 and 7 Princes-square, London,—"Hexagonal hinged box for matches."
26th,	1749.	William Riddle, Whitefriars,—"Porte Flacon, or wine handle."
—	1750.	William Dixon, Liverpool,—"Window ventilator."
—	1751.	Ebenezer Rogers, Abercorn, Monmouthshire,—"Rest for the forward ends of loaded carriages while being tipped."
—	1752.	Thomas Ash, Birmingham,—"Fastening for stair-carpets."
27th,	1753.	Frost, Noakes, and Vincent, Brick-lane, Whitechapel,—"Steam pressure guage."
29th,	1754.	Rebecca and Emma Alcock, Doctors' Commons,—"Bust improver."
30th,	1755.	Samuel Sbeppard, Birmingham,—"Tsp."
—	1756.	Barwell & Co., Northampton, Eagle Foundry,—"Heat-diffusing stove."
31st,	1757.	J. Robinson & Co., Commercial-road East,—"Improved waistcoat."
Feb. 2d,	1758.	Robert Adolphe Farmar, Mount-street, Lambeth,—"Case bottle stopper."
—	1759.	Joseph and Edmund Ratcliffe, Birmingham,—"Spring for opening and closing the covers of ink and other vessels."
—	1760.	Frederick Westley, Strand,—"Polychrest envelope."
—	1761.	Thomas Smith, Prince's-street, Lambeth,—"Automatic or self-acting flushing apparatus."
3d,	1762.	F. and C. Hazell, Gloucester-street, Clerkenwell,—"Paragon spring swivel."
5th,	1763.	Thomas Wharton, Birmingham,—"Victoria ink-pot."
6th,	1764.	John Oliver York, Covent-garden,—"Instrument for measuring diameters."
7th,	1765.	Josiah Jackson, Birmingham,—"Pen."
—	1766.	William Riddle, East Temple Chambers, Whitefriars,—"Self-igniting gas-burner."
—	1767.	Campbell and M'Nah, Greenock,—"Apparatus for casting sugar-moulds."
—	1768.	John Key, Wemyss Colliery,—"Stop-cutting apparatus for tile machinery."
8th,	1769.	S. Newington, Keale Park, Kent,—"Hand row hoe, and cultivator."
—	1770.	T. Tillock, Bond-street,—"Haut-ton vesture."
—	1771.	Bedington and Docker, Birmingham and London,—"Double Argand lamp."
9th,	1772.	E. Ranwell, Red Cross-square, London,—"Improved scale pan for weighing and discharging coal and other materials."
—	1773.	W. Winsor, Rathbone-place,—"Harding's lesson-desk."
—	1774.	Elias and Reuben Levy, Manchester,—"Leviathan vest."
—	1775.	Joseph Lillie, Manchester,—"Improved boiler with internal flues."
—	1776.	Samuel Clutton, Paddington,—"Cold draught preventer."
10th,	1777.	J. N. Marshall, Bristol,—"Heated air propeller."
—	1778.	H. L. Marshall, and Samuel Bayless, Oxford-street,—"Adjuster to be applied to braces and fasteniugs for waistcoats, trousers, drawers, belts," &c.
14th,	1779.	Scholfield and Sons, Birmingham,—"A gamella or gold washer."
—	1780.	Job Clark, Willen Hall, Staffordshire,—"Safety spring bolt."
15th,	1781.	T. H. Busbridge, and G. F. Busbridge, East Malling, Kent,—"Dandy roller for paper-making."

TO READERS AND CORRESPONDENTS.

Dico, Edinburgh.—We are not sure that we comprehend what he means by "an Index in a separate form." The year's Index, as he will see by the present part, is printed to bind up with the volume. It may be arranged as he chooses, or may be taken out altogether.

A. K. Birmingham.—His system of tubing, connected by flexible junctions for telegraphing on railway trains, has been frequeutly proposed, and, we believe, tried on some railways. The difficulty in the way of its application, appears to have been the time taken up in adjusting and keeping the tubes in repair.

G. Wilton.—The inventor's name is attached to the article. Address "Railway Foundry, Hunslet, Leeds."

E. D. London.—Any notes on the subject he mentions will be very acceptable.

J. F. Strong, Ipswich.—His solution came to hand too late for present notice.

G. M. London.—The same note will apply here. Both communications will receive due attention in our next part.

J. Walters.—We are willing to accommodate him, but still think that the amendments he proposes would not render the matter any plainer than it now is.

W. R. S.—Railways are curved, because they have—to speak somewhat unmechanically—to pass round corners. Will he show us how to do this with right lines?

INDEX.

A

PAGE

Abstracts of Recent Specifications:—(See "Patents, Specifications of Recent.")
Academy, Exhibition of Pictures at the Royal,... 60
Acid, a New, and Alkaline Salt, Discovery of,.... 29
Acoustics, ... 223
Address, the Conductors',..... 1
Agricultural Mechanics: Highland Society's Edinburgh Exhibition, Agricultural Society's Exhibition at York, The Royal,..... 133
Air Pump and Atmospheric Railway,..... 19
Alarm Whistle, Self-acting, and Pressure-guage for Steam Boilers,..... 20
American Patents:—
Composition for Paints, Braman; Springs, Lewis,..... 109
Planing, Tonguing, Grooving, &c., Cumberland; Rack Wrenches, Avery; Boiler Explosions, Stillman,.....135-6
Anastatic Printing,..... 47
Anatomy of the Physical Structure of the Universe, ...54, 81, 106, 146, 175, 201, 222, 268
Animalcules,..... 49
Antimonial Paint,..... 22
Apparatus for Steaming food for Cattle, Portable, 181
Application, Age of,..... 2
Architect, Builders, and Contractor's Pocket Book, for 1849, Weale,..... 233
Architects, Royal Institute of,..... 118
Arithmetic, Calder's Familiar Explanation of,.... 136
Art-Manufactures Circular,..... 262
Astronomy, Outline of,..... 148, 171, 194, 270
Astrotype,..... 222
Athenæum, Report of the Glasgow, 1848,..... 87
Atlantic, First Voyage across the, ... 5
Atmosphere,..... 124
Atmos the Giant: a quaint story of Steam,..... 221
Atmospheric Railway—Air Pump, and the, ... 19
Atmospheric Railway—Piatti's System,..... 157
Atmospheric Railway, Low-pressure,..... 214
Aurora Borealis of the 17th Nov. 1848,..... 243
Australian Copper Mines,..... 8
Automatic Safety Valve, Walmsley's,..... 181

B

Balance Valve for Locomotives,..... 261
Balancing Railway Wheels,..... 114
Bann Reservoir,..... 46
Barometer, Pastorelli's Dial House,..... 262
Beams, Porter's Corrugated Wrought-iron,..... 247
Beauregard's Patent Steam Engine,..... 200
Beautiful, on the Production of the,..... 47
Birmingham and its Manufactures,..... 265
Blackburn Market-House,..... 156
Blast Furnaces, Uses of escape Gases of,..... 163
Blow, the power of a..... 3
Blowing Machinery, Lloyd's, ... 158
Boiler, Alarm Whistle, and Pressure Guage for,.. 20
Boiler and Condenser, Craddock's,..... 89, 116
Boiler Explosion at Dudley,..... 117
Boiler Explosions,..... 140
Boiler Explosions—Injection of Cold Feed Water,..... 184
Boiler Explosions—Steam-Engine Management, 145
Boiler, High Pressure, for M'Naught's Double-Cylinder Engine, Plates, 18, 19,..... 177
Boilers, New Feed-Apparatus for,..... 11
Boilers, Water-Feed and Guage for,..... 65

PAGE

Bone Manure Machine,..... 139
Bone-Mill, Lawes',..... 33
Branch Traffic, Adams' Locomotive Carriage for, 193
Branch Railways, Adams' Composite Carriage for, 276
Break Apparatus,..... 141
Break for Railway Carriages, Stephenson's Self-Acting,..... 52
Brick and Tile Machine, Gair's, ... 262

C

Caffettiere and Infusion Pot, Waller's,..... 22
Cambrian Locomotive, Mess. Thwaites, 23, 71, 80, 105
Cambrian Steam-Engine,..... 105
Canal, the Marseilles,..... 79
Carriage, Morrison's Automatic,..... 65
Carriages, English Pleasure,..... 256
Carbonic Acid Gas, a Preventive of Cholera,..... 184
Catalysotype,..... 222
Cattle, Portable Apparatus for Steaming Food for, ... 181
Cements of England, the Water,..... 62
Cements, Experimental Tests of,..... 106
Cements, Mortar, and Limes, Observations on the Cohesive Power of,..... 179
Chat Moss, on the Drainage of a Portion of,..... 189
Chairs Railway, Darling's Improvements in Moulding,..... 15
Chair, Yules' Railway,..... 14
Chemistry of the Steam-Engine,..... 43, 67
Chess Knight's March, Magic Square of,..... 185
Chimney Top, ... 231
Chimneys, Round,..... 4
Cholera, Carbonic Acid Gas, as a Preventive of,.. 184
Chrysotype,..... 222
Cburn and Cheese Press, ... 262
Circles, Diameters and Circumferences of,..... 213
Coal, on the Formation of, 20, 88, 113, 166, 184, 211, 235, 258
Coals for the Steam Navy, Report of Experimental Investigations on,..... 30, 50, 74, 102
Coals, Gas from different,..... 94
Coal and Iron Districts, Report on,..... 166
Coal in South Wales, ... 189
Cofferdam, Portable, for Harbour and Marine Works,..... 103, 137
Coke, the Manufacture of, Practical Notes, 169, 193
" " " 203
Coke, Peculiar Property of,..... 163
Compressed Air Railway System, Piatti's,..... 157
Concentric Balls of the Chinese,..... 215
Condensing Engines, Joyce's Double-Cylinder, Pendulous, Plates 1 and 2,..... 9
Condensing Engines and Mill-Work, Joyce's Double-Cylinder Pendulous,..... 33
Condensation of Steam,..... 184, 258
Conductors' Address,..... 1
Constructive Machinery:—
Shank's Slotting Machine,..... 73
Cooking and Roasting Apparatus,..... 220
Copper Mines, Account of the South Australian, 8
Cork Buffing and Drawing Apparatus, Todd's,... 246
Correspondence:—
Annular Appearance of Gases Evolved by the Discharge of Fire-Arms, ... 258
Coal, Formation of, 20, 88, 113, 166, 184, 211, 235, 258
Coffer-Dam, Wrought-Iron, Portable, ... 137
Condensation of Steam,..... 184, 258, 282

PAGE

Cone-Pulleys, Steel-Yard Levers, Teeth of Wheels,..... 166
Decimal System of Currency,....68, 113, 114, 136
Diameters and Circumferences of Circles,..... 213
Double-Cylinder Steam-Engine, M'Naught's, 35,152
Electricity, What is?..... 44
Electric Light for Mines,..... 282
Engineering Literature, ... 159
Explosions in Steam-Engines, Certain Prevention of, ... 234
Frame-Work, Question in, ... 259, 282
High-Pressure Steam, Phenomenon attending Discharge of, ... 214, 235
Hydrostatic Pressure as a Substitute for Manual Labour,..... 234
Hydrostatic Pressure Engine, Armstrong's,.... 234
Link Motion for a single Eccentric, Reversing, 160
Locomotives with Inside Cylinders, and Outside Valve-Gearing,..... 235
Logarithmical Tables, Improvements in,..... 138
Niello-Metallic Engraving,..... 69
Practical Question, Answer to a,..... 236
Problem by Mr. Walters,..... 160
Problem, Solution of a,..... 136
Railway Signalling, Employment of Bells for, 212
Railway Signalling—A Whistle for the Guard, 257
Railway Trains, Communication in,..... 67
Railway Trains, Resistance to,..... 235, 281
Rotatory Engine, Sharps',..... 138
Rotatory Printing Machine,..... 183
Ruler, Sliding Parallel, ... 20
Safety-Lamps, the Use of Glass in,..... 281
Screw-Key, Park's Improved,..... 20
Screw-Propeller, on Driving it direct, ... 236
Slide-Valve, Improved,..... 44
Steam-Boiler Explosions—Injection of Cold Feed Water, ... 184
Steam-Engines, on the Effect of Diminished Atmospheric Pressure upon,..... 214, 234
Steam-Engine, Craddock's, Improvements in, 112
Steam-Engines, M'Naught's Improvements in, 69
Stone-Floats, Corrosion of, in Steam-Boilers, 136
Square for finding Centres of Circles,..... 69
Thermometric Observations,... 183, 212, 258, 283
Tracing Paper, How to Make,..... 257
Vulcanized India-Rubber for Stuffing-Boxes,... 236
Water, Steam, and Air, Relative Density of, ... 233
Whistle, and Pressure-Guage for Steam-Boilers, 20
Corrugated Wrought-Iron Beams, Porter's,..... 247
Corrosive Fluids, Stop-Cock for,..... 129
Cottage Range, Nicholson's, Newark,..... 135
Covering for Waggons, Hill's Improved,..... 226
Crank-Cutting Machine—Workshop Economics—Constructive Machinery,..... 104
Crane's Safety Mining Lantern,..... 150
"Cricket" Steamer, Case of the,..... 23
Crown Glass, its History and Manufacture, ... 126
Curiosities of the Application of Sand, ... 12
Cyanotype,..... 222

D

Daguerreotype,..... 202
Davies' Rotatory Engine,..... 269
" " Dredge on, ... 281
Designs for Articles of Utility, (see "Registered Designs"),.....
Designs, Tradesman's Book of Ornamental,... 18, 44

PAGE

Detaching Catch for the Prevention of Over-winding, ... 79
Diamond, on the Conversion of, into Coke,..... 118
Die Sinking,..... 266
Domestic Utensils, Improvements in—Rodger's Table-knife, Butler's Cooking Apparatus,... 220
Double-cylinder Steam-Engine, M'Naught's,..... 35
Double-cylinder Pendulous Engine, Joyce's, Plates 1, 2, 3, and 4,.....9, 33
Double-cylinder Steam-Engine, Gilbert, ... 239
Double-cylinder Marine Engine, M'Naught's, Plate 14,..... 152
Drainage of a Portion of Chat Moss,..... 189
Drawing and Buffing Apparatus, Tod's Cork,..... 246
Duplex Block for Printing Yarns,..... 231
Diamagnetic Force, on some New Relations of, 143

E

Eccentricities, Mechanical—Roberts' New Element of Mechanism—Thomson's Multiplying Gearing,..... 150
Elasticity of Spiral Springs,..... 244
Electrical Science, Papers on, (see Anatomy of the Universe,)..... 9
Electrical Condition applied to Facts,..... 112
Electricity,..... 54, 81
Electricity, Voltaic, Testing Metals by,..... 55
Electricity, What is?..... 44
Electricity, Weale's Rudimentary Works, Rev. Snow Harris,.. 256
Electric Clock,..... 261
Electric Telegraph for Metereological Purposes,... 107
Electro-Printing, Process for Porcelain, Smith's, 157
Energiatype..... 222
Enfeebled Hands, Pen for,..... 210
England, the Water Cements of,..... 62
Engineering, Literature of,..... 121, 159
Engineering of the Rhine and Moselle,..... 45
Engineer's and Contractor's Pocket-Book, 1847-8, 19
Engines and Gearing at Cowlairs Station,..... 25
Engraving, Niello-Metallic, ... 12, 69
Envelope Preserver,..... 239
Equilibrium Lamp,..... 85
Euphorbia Officinarum, Discovery of a New Acid in, 29
Exhibition of Society of Arts,..... 21
Exhibitions of Pictures of Royal Academy,..... 60
Experiments with Narrow-Guage Locomotives,... 59
Experimental Test of Cements,..... 106
Explosion causing the Great Fire at New York in 1845, on the Rationale of the,..... 129
Explosions, Boiler—Steam-Engine Management, 145
Express Locomotive Engine,..... 116
Explosion in Steam-Engines, Prevention of,... .. 234

F

Fairfield Locomotive Carriage,..... 194
Fan-Blast, Series of Experiments relative to, 38, 55
Fan-Blast Flour-Dressing Machine,..... 109
Fan-Blower, Steam-Propeller for the,..... 154
Farmer's Portable Mill,..... 262
Feathering Paddle-Wheel, Mennie's,..... 275
Feed Apparatus for Steam-Boilers,..... 11
Fire-Cock or Hydrant, Improved,..... 179
Fire-Cock, Chrimes',..... 209
Fire-Engine, White's New,..... 261
First Voyage across the Atlantic,..... 5
Flap-Valve for Sewers,..... 230
Flour-Dresser, Brockliss',..... 239
Fluids, Stop-Cock for Corrosive,..... 129
Food for Cattle, Portable Apparatus for Steaming, 181
Ferrotype,..... 222
Forgery, Protection against,..... 60
Forge, Chaplin's Portable,..... 225
Fork for Weft Protector,..... 182
Fowling-Pieces and Leaden Shot,..... 266
Frame-Work, Question in,..... 259
Franklin Institute,..... 119
French Mechanical Periodicals,..... 157
Friction-Break,..... 252
Friction-Clutch, Ashley's Screw,..... 239
Fruit Tiles and Flour Supports,..... 247
Fuel, Mechanical Virtue of,..... 263

G

PAGE

Gas Illumination of the Stained-Glass Windows of the House of Lords,..... 81
Gas Lamp, Holliday's Self-Generating,..... 180
Gas-Light Regulator,..... 34
Gas, Management of,..... 167
Gas-Exhauster, Jones'..... 266
Gases from different Coals,..... 94
Gearing and Stationary Engines at Cowlairs, Edinburgh and Glasgow Railway, Practical Notes, ... 25
Geology of South Wales, Gloucester, and Somerset, ... 188
Geology of Pennsylvania,..... 189
——— Weale's Rudimentary Works, Portlock,.. 256
Gilded Silk, ... 47
Girders for Bridges, Experimental Trial of,..... 167
Girders, the Dynamical Deflection of Railway,... 178
Glass, History and Manufacture of Crown, ... 126
Glass Button-Making,.... 265
Glyphography, late Specimens of 32
Gorhals Gravitation Water-Works, Practical Notes, ...97, 123
Guage, Hydrostatic Indicator or Pressure,..... 174
Guage-Pipe for Measuring the Flow of Water,.... 130
Guage for Steam Boilers, ... 43
Guage, Whistle, and Pressure, for Steam Boilers,... 20
Gutta Percha, Applications of, ... 164

H

Hammer, Self-acting Apparatus, of Nasmyth's, Steam, Practical Ingenuities,..... 77
Hands, Holtzapffel's Pen for Enfeebled, ... 210
Harbour and Marine Works, Portable Coffer-Dam for, ... 103
Harbour Screw-Cramps, Stevenson's,..... 261
Harbours of Refuge,..... 89, 114
Harbours, on, ... 70
Hastie's Method of Driving Corn-Mills, ... 84
Heaton's Method of Balancing the Reciprocating Parts of Locomotive Engines,..... 108
Heat,..... 263
High-Pressure Steam, Phenomena attending the Discharge of,..... 214, 235
Horticultural Apparatus—Roberts' Fruit Tiles and Flower Supports, ... 247
House Painter and Colourman, M. Vanherman's, 232
House of Lords, Gas Illumination of the Windows of,..... 81
Hydraulic Dock, ... 261
Hydraulic Starting Apparatus,..... 91
Hydraulic Pressure Engine, ... 164
Hydraulic Machinery, Improvements in:—Chrimes' Fire-Cock—Kirkwood's Piston-Cock, 209
Hydrant, or Fire-Cock, Improved,..... 179
Hydrographic Map of the British Isles,..... 189
Hydrostatic Pressure, as a Substitute for Manual Labour,..... 000
Hydrostatic Pressure Engine, Armstrong's,...234, 244
Hydrostatic Indicator, or Pressure Guage,..... 174
Hydrostatic Jack, Simmons', ... 266

I

Illustrated Juvenile Literature,..... 262
Incline of the Edinburgh and Glasgow Railway, Stationary Engines at, ... 25
Indian Iron,..... 155
Indurated Stone, Hutcheson's,..... 262
Institution of Civil Engineers, (see Proceedings of Scientific Societies.)
Institution of Mechanical Engineers, (see Proceedings of Scientific Societies.)
Inventors and Inventing, ... 2
Iron Market-House at San Fernando, Trinidad, Plates 21 and 22, ...207, 224
Iron Steam-Tug Wizard,..... 107
Iron, Strength of, ...22, 46, 71, 94, 237, 260

J

Jacquard, Application of, to Printing Warps,..... 41
Jenny Lind Locomotive, Plates 23—26,.....248, 268

PAGE

Joyce's Double-Cylinder Steam-Engine, Plates 1, 2, 3, and 4,..... 9, 33

L

Labour, on the Extension of our Outlets for—Mr. Dempster's Trawl-Fishing Apparatus,.. 219
Lamp, Holliday's Self-Generating Gas,..... 180
Lamp, Robertson's Equilibrium,..... 85
Lantern, Crane's Safety-Mining,..... 150
Launch, ... 23
Leaden Shot and Fowling-Pieces,..... 266
Leather Articles, Process of Manufacturing without a Seam, ... 135
Letters and Parcels, Bryden's Receiving-Box for, 225
Library, the Mechanic's,.....83, 119, 138, 157, 181, 210, 226, 252, 276
Life and Character of George Stephenson, the,... 205
Light, ...106, 146, 175, 201, 222
Light, on a Modification of the Theories of Refraction and Reflection of,..... 153
Lime,..... 207
Limes and Cements, Observations on,..... 17
Link Motion for Single Eccentric,..... 160
Literature of Engineering, The,...121, 159, 181, 210, 226, 252
Lithography, Present Condition of,..... 263
Lithographic Printing, Improvements in,..... 239
Locomotives:—
" Heaton's Method of Balancing the Reciprocating Parts of,..... 108
" Messrs. Wilson's,..... 71
" Messrs. Thwaite's Cambrian, ...23, 71, 80
" Samuel's Express,..... 116
" Engines for Common Roads, Sir J. Anderson's Steam-Carriage, ... 119
" Narrow Guage, Experiments with, ... 59
" Carriage for Branch-Carriage, Adams', Plate 20,..... 193
" Carriage, Adams' Composite, ... 275
" M'Conochie & Claude's, ... 181
" Carriage for Branch Traffic, Adams', 193
" " " 275
" Balance Valve for,..... 261
" Passenger Engine, "Jenny Lind," ... 248
" " " 268
" Cambrian Engine,..... 236
" With Inside Cylinders and Outside Valve Gearing,..... 235
Logarithmical Table,..... 138

M

Machinery, Political Economy of,..... 241
" Progression of, "Times" Printing Machine,..... 248
M'Naught's Double-Cylinder Steam-Engine,..... 35
Magic Square of the Chess Knight's March,..... 185
Mahogany *v.* Oak,..... 47
Manifold Writer and Clip Desk, Wedgewood's,... 239
Manufactures of Birmingham, ... 265
Marine Engine, M'Naught's Patent Double-Cylinder, ... 152
Marine Engines, Oscillating, with the "Link" Reversing and Expansion Motion,.....58, 80
Market-House, Blackburn,..... 156
Market-House at San Fernando, Plates 21 and 22,..... 207, 224
Marseilles Canal, the,..... 79
Materials, Strength of,.....22, 46, 71, 94, 237, 268
Materials, Strength of, Thomson's,..... 273
Mathematician, Simpson the,..... 28
Mechanics of Agriculture, Thewlis' and Griffith's Churn and Cheese-Press,..... 262
Mechanics, Agricultural, Highland and Agricultural Society's Exhibition at Edinburgh,..... 133
Mechanical Eccentricities, Roberts' New Element of Mechanism—Thomson's Multiplying Gearing, ... 150
Mechanic's Library, the,.....83, 119, 138, 157, 181, 210, 226, 252, 276
Mechanical Periodicals, French, ... 157
Mechanics, Theoretical and Practical, Hann's,.... 233
Mechanical Virtue of Fuel, How it is Estimated, 263

PAGE

Metallic Packing for Stuffing-Boxes, Hunt's,..... 176
Mill, Farmer's Portable,..... 262
Mill for Grinding Bones,..... 33
Mills, Hastie's Method of Driving Corn,..... 84
Mines, Account of the South Australian Copper, 8
Mill-Work, Joyce's Double Cylinder Pendulous Condensing Engines,..... 33
Mines of Mexico,..... 22
Mining Lantern, Crane's Safety,..... 150
Mine Ventilation, Improved Pit-valve,..... 13
Mirage,..... 81
Momentum, On,..... 174
Monthly Notes:—
Agriculture, Mechanics of, Thewlis and Griffith's Churn and Cheese Press,..... 262
Anastatic Printing,..... 47
Annulus Scapus, Dubois,..... 239
Antimonial Paint,..... 22
Art-Manufactures' Circular,..... 263
Barometer, Dial House, Pastorelli's,..... 262
Brick and Tile Machine, Gair's,..... *ib.*
"Brigand" and "Pirate" Screw Steam Ships,. *ib.*
Cannon, Mandslay's Improved,..... 287
Certain Trades, Rapid Extension of,..... 22
Cholera,..... 166
Clutch, Screw Friction, Ashby's,..... 239
Coal and Iron Mining Districts, Lanarkshire, State of,..... 167
Concentric Balls of the Chinese,..... 215
"Cricket" Steamer, Case of the..... 23
Daguerreotype Plates, Preparation of, by the Electrotype,..... 119
Dover Refuge Harbour,..... *ib.*
Electro-Magnetism as a Moving Power,..... 287
Envelope, the Preserver..... 239
Flour-Dresser, Brockliss,'..... *ib.*
Fuel, Mechanical Virtue of, how Estimated and Expressed..... 263
Girders for Bridges, Experimental Trial of,.... 167
Indurated Stone, Hutchisou's,..... 262
Launch..... 23
Literature, Juvenile, Illustrated,..... 262
Lithographic Printing, Improvement in,..... 239
Lithography, Present Condition of,..... 263
Locomotive, Messrs. Thwaite's,..... 23
Lodging Houses, Model,..... 167
Mahogany *v.* Oak,..... 47
Manifold-Writer and Clip-Desk, Wedgewood's, 239
Mill, Farmer's Portable, Whitton's,..... 262
Mines of Mexico,..... 22
Paper, Process for Splitting,..... 287
Pipe and Tile Machine, Webster's Hand,..... 287
Pumps, Method of Working at Sea, by the Wind, 119
Railway Carriages, Oscillation of,..... 191
River-Boats, Joyce's,..... 287
Silk, Gilded,..... 47
Scoop-Wheel Draining,..... 287
Steam-Engine, Gilbert's Double Cylinder,..... 239
Surface-Clearer for Plumber's Work,..... 287
Timber, Preservation of,..... 287
Time, on the Notation of,..... 191
Trawl-Fishing, Mr. Dempster's Experiments in, 239
Viaduct across the Dee, Vale of Llangollen,... 167
Wood, Payne's Patent for Preserving,..... 166
Moon, Photographic Camera for,..... 222
Mortar and Cements, Cohesive Power of,..... 181
Mortice and Tenon-cutting Machine, Mortimer's, 16

N

Narrow-Guage Locomotives, Experiments with,.. 59
Natural Philosophy, Introduction to, Tomlinson, 182
Neptune, the Planet, M. le Verrier's Explanation, 176
Newark Cottage Range, Nicholson's,..... 135
Niello-Metallic Engraving,..... 12, 69
Notation of Time,..... 191
Notes of a Southern Journey,..... 217

O

Oil Test, Thomas',..... 273
Ornamental Designs, Tradesman's Book of,..... 18
Oscillating Marine Engines..... 58, 80
Oscillation of Railway Carriages, Prevention of, 191

P

PAGE

Paint, Antimonial,..... 22
Papers on Electrical Science,..... 9
Parallel Ruler, Sliding, (*Illus.*)..... 20
Parian Cement,..... 217
Pen for Enfeebled Hands, Holtzapffel's,..... 210
Pendulums, Resistance of the Air to,..... 188
Pentagraphic Delineator, Robertson's,..... 230
Photographic Camera for the Moon,..... 222
Photography,..... 202
Pictorial Gift Book,..... 44
Pipe Guage for Measuring the Flow of Water,... 130
Pipe Sockets, Improvements in,..... 157
Piston-Cock, Kirkwood's,..... 209
Pit-Valve, Simpson's Improved,..... 13
Planet Neptune, M. le Verrier's Explanation,..... 176
Planets, the,..... 194
Pneumatic Springs for Railroad Cars,..... 109
Patents, Abstracts of Specifications of Recent,—
Accelerated Menattrite Locomotion, Miller, ... 253
Air Spring, Beattie,..... 255
Bands for Hats, Caps, and Shoes, Walker..... 254
Bricks and Tobacco-Pipes,..... *ib.*
Brick Kilns, Swain..... 278
Casks and Cutting Wood, Robertson,..... 279
Clocks and Telegraphs, Roberts,..... 277
Closing Tubes—Removing Incrustations in Boilers, Seaton,..... 228
Copper Ores, Penny,..... 227
Corn Mills, Hastie,..... 84
Cotton Machine, Wilson,..... 279
Curing Smoky Chimneys, Hart,..... 276
Dibbling and Propelling Vessels, Ross,..... 277
Electric Light, Le Molt,..... 278
Electric Light, Staite,..... 276
Engines, Locomotive, Marine, and Stationary, Remington,..... 227
Engines and Machinery for Propelling, Beale,. 253
Flax and Tow, Martin,..... 276
Fringes, Gimps, and Bullions, Dalton,..... 229
Fur Fabrics, Westhead,..... 252
Fuel, Furnaces, Gas, and Consumption of Smoke, Emmott,..... 253
Gas Burners and Candle Lamps, Clark,..... *ib.*
Gas and Retorts, Barnes,..... 229
Gas Meters, King,..... 279
Gas, Tar, Charcoal, and Acids, Solomons and Azulay,..... 227
Gas, Robertson,..... 255
Glass for Nautical and Architectural Purposes, Newton,..... 279
Gutta Percha and Caoutchouc, Lorimer,..... 277
Heaton's Method of Balancing Reciprocating Parts of Locomotive Engines,..... 108
Jacquard Machine, Mackenzie,..... 279
Letterpress Printing, Newton,..... 278
Letterson Glass, Marble, and Wood, Lamenaude 277
Looped Fabrics, Mowbray,..... 253
Locomotives, M'Conochie and Claude's,..... 181
Making Skeins of Silk, Foot,..... 230
Malt Liquors, Bursill, Paterson, and Mathews, 227
Manufacture of Metals, Hunt,..... 252
Manure, Richardson,..... 226
Mariner's Compasses and Barometers, Napier,. 278
Matches and Ligbt, Archer,..... 253
Mats, Borsham..... 228
Motive Power, Darlu,..... 230
Motive Power, Macintosh,..... 254
Obtaining Metals, Hunt,..... 253
Papier Maché, Brindley,..... 229
Peat, Fuel, and Manure, Rodgers..... *ib.*
Plastic Substances, Shaping, Hancock,..... 279
Power, Morison's Improvements in applying,... 63
Preparing and Cleaning Minerals, Capper,..... 229
Preserving Animal Products, Louis,..... 227
Printing-Ink, Pratt,..... 279
Propelling, Poole,..... 227
Propelling, Taylor..... 279
Railway Chair, Yule,..... 14
————, Darling,..... 15
Railway Wheels, Kirtley,..... 277
Railway Wheels, Lathrop,..... 229
Recording Votes at Elections, Chamberlaine,... 252
Roasting Coffee, and Making Infusions, Dakin, 255

PAGE

Sawing, Barber,..... 228
Springs, Turton,..... *ib.*
Soap, Castelain,..... 277
Stays, Boots, and Fastenings, Thomas,..... 278
Steam and Motive Power, Beauregard,..... 277
Steam-Engines and Boilers, Stenson,..... *ib.*
Steam-Engines and Breaks, Thornton and M'Connell,..... 280
Stoves, Grates, and Furnaces, Newton,..... 276
Sugar, Steinkamp,..... 278
Threshing and Dressing Cone, Palmer,..... 255
Timber-loaded Vessels, Apparatus for Saving, Purnell,..... 278
Tobacco Pipes, Steel and Britter,..... 276
Tubes, Roose and Richardson,..... 253
Tubes, Taylor,..... 226
Twisting and Doubling Cotton Yarns,..... 227
Vehicles for Railways and Common Roads, Mansell,..... 228
Walls, Piers, and Breakwaters, Beardmore,.... 254
Warps, Improvements in Printing, Cochran,... 41
Weaving and Printing Carpets, Wood,..... 228
Patents, Lists of Recent:—
English, 23, 48, 72, 96, 120, 144, 168, 191, 215, 239, 263, 287
Scotch, 24, 48, 72, 96, 120, 144, 168, 192, 216, 240, 264
Irish, 24, 48, 72, 96, 120, 144, 168, 192, 216, 240, 288
Political Economy of Machinery,..... 241
Porcelain, Smith's Electro-Printing Process for... 157
Portable Coffer-Dam for Harbour and Marine Works,..... 102
Portable Forge, Chaplin's,..... 225
Porticoes and Theatres of Ancient Rome,... 100, 132
Power of a Blow,..... 3
Practical Ingenuities, Self-Acting Apparatus of Nasmyth's Steam-Hammer,..... 77
Practical Notes, Manufacture of Coke,..... 169, 203
———— Stationary Engines at Cowlairs, on the Incline of the Edinburgh and Glasgow Railway,..... 25
Preston Institution, 20th Annual Report of,..... 233
Printing Machine, Rotatory,..... 183
Printing Warps, Cochran's,..... 41
Problem, A,..... 19, 137, 160
Proceedings of Scientific Societies:—
Architects, Royal Institute of British,..... 118
Athenæum, Glasgow,..... 87
British Association for the Advancement of Science,..... 142, 161, 186, 214
Civil Engineers, Institution of, 21, 45, 70, 89, 114, 259, 283
Franklin Institute,..... 119
Mechanical Engineers,..... 70, 89, 114, 138, 236
Meteorological Society of London,..... 142
Royal Institution,..... 118, 286
Royal Scottish Society of Arts, 22, 46, 71, 94, 237, 260
Society of Arts,..... 21, 93, 142, 284
Production of Silver in Spain,..... 105
Propeller, Steam, for the Fan Blower,..... 154
Protractor, Simpson's Duplex Straight-Edge,..... 85

Q

Question, Practical,..... 184
" " Answer to,..... 236
" In Frame-Work,..... 259, 282

R

Railway Air-Pump and Atmospheric,..... 19
" Bars, Steam Saw for Cutting,..... 173
" Break, Chesshire's,..... 91
" Carriages, Self-Acting Break for, ... 52
" Carriage, Prevention of Oscillation of,.... 191
" Collision Break Apparatus, ... 141
" Economics, Adams' Locomotive Carriage, Plates 20,..... 193, 275
" Girders, on the Dynamical Deflection of, 178
" Junctions, Method of setting out,..... 45
" Locomotion and Steam Navigation, (rev.) Curr, ... 211

PAGE

Railway Low Pressure, Atmospheric,..... 215
" Signals, Employment of Bells for,..... 212
" Signals, Improvements in,..... 149
" System, Facts bearing on the Progress of,..... 190, 214
" System, Piatti's Compressed Air,..... 157
" System, who originated the,..... 185
" Trains, on the Resistance to, 46, 70, 197, 235
" " " 281
" Transit, ... 217
" Wheels, Comparative Account of,..... 112
" Wheel Tyres, Banks',..... 92
" Wheel Tyres, Evans' Improvements in Fitting on,..... 57
Range, Nicholson's—Newark Cottage,..... 135
Rapid Extension of Certain Trades,..... 23
Rationale of the Explosion causing the Great Fire at New-York,..... 129
Readers and Corrrespondents, 24, 48, 72, 96, 120, 144, 168, 192, 216, 240, 264, 288
Receiving-Box for Letters and Parcels,..... 225
Recent Patents, (See "Patents, Abstracts of,")
Refraction and Reflection of Light,..... 153
Regent Street Colonnade,..... 218
Registered Designs, Specifications of Recent:—
Chimney Top, Ferguson and Miller,..... 231
Diaphragm Double Sewer, for Separating or Combining House Drainage and Surface Drainage, Moffat,..... 255
Duplex Block for Printing Yarn, Barr,..... 231
Duplex Straight-Edge Protractor, Simpson,... 85
Equilibrium Lamp, Robertson,..... 85
Fan-Blast Flour-Dressing Machine, Southam, 109
Flap-Valve for Sewers, Humphreys and Thirst, 230
Hydrostatic Pressure Regulator, Bryce,..... 255
Mortice and Tenon-Cutting Machine, Mortimer, 16
Pentagraphic Delineator, Robertson,..... 230
Silent Shears, Wilson,..... 210
Steam-Boiler Water-Guage, Robinson, ... 43
Stop-Cutting Apparatus for Tile Machinery,... 280
Sugar Moulds, Apparatus for Casting, Campbell and M'Nah,..... 280
Water-Feeder Guage and Alarum for Steam-Boilers, Crichton, ... 65
Water-Valve for Stand Pipes, Rontree and Brown,..... 256
Regulators, Gas-Light,..... 34
Resistance to Railway Trains,..... 46, 70, 197, 235
Reviews of New Books:—
Air-Pump and Atmospheric Railway, Turnbull, 19
Architect, Builder, and Contractor's Pocket-Book for 1849, Weale, ... 233
Arithmetic, Familiar Explanation of, Calder,.. 136
Designs, Tradesman's Book of Ornamental,.. 18, 44
Electrical Condition applied to Facts, Coxworthy, ... 112
Electricity, Snow Harris,..... 256
English Pleasure Carriages, Adams,..... 256
Engineer's and Contractor's Pocket-Book for 1847-8, Weale, ... 19
Explosions in Steam-Engines, Wilder,..... 111
Geology: Weale's Rudimentary Works, Portlock, 256
Gift-Book, Pictorial,..... 44
High-Pressure Steam-Engine, Alban,.....86, 109
House-Painter and Colourman, Every Man his Own, Vanherman, ... 232
Limes and Cements, Observations on, Pasley, 17
Mechanics, Theoretical and Practical, Hann,... 233
Natural Philosophy, Introduction to the Study of, Tomlinson, ... 182
Preston Institution, Twentieth Annual Report of, 233
Railway Locomotion and Steam Navigation, Curr, 211
Railway Wheels, Comparative Account of, Barlow,..... 112
Report on the Supply of Surplus Water to Manchester, Homersham, ... 110, 158
Roads, on the Advantages of Cleanliness in, Whitworth,..... 86
Rotatory Engine, Davies', Dredge on,..... 281
Screw-Threads, Uniform System of, Whitworth, 86
Stars, Hand-Book for the, Jeans,..... 183
Steam-Engine, a Rudimentary Treatise on, Lardner, ... 231

PAGE

Steam-Engine, Chemistry of the, Craddock, 43, 67
Tredgold on the Steam-Engine, ... 159, 232
Trigonometry, Plane and Spherical, Jeans,..... 18
Water Supply of Plymouth—Letter to Viscount Ebrington, on, Beardmore, ... 280
Well-Digging, Boring, and Pump-Work, Swindell, ... 256
Young Surveyor's Preceptor, Reid, ... 66
Rhine and Moselle, Engineering of,..... 45
Rotatory Engine, Davies',..... 249, 269, 281
" " Fallacies of the,..... 138
Russian Steam Frigate "Vladimir,"..... 178

S

Sand, Curiosities of the Applications of,..... 12
Sawing-machine, Cross-cut,..... 262
Screw-key, Park's Improved,..... 20
Screw Propeller, On Driving the, Direct,..... 236
Screw Threads, On a Uniform System of,..... 86
Scientific Discovery, Progress of, in the 17th century, ... 36
Sea, the,..... 82
Sea Wall, Edinburgh and Dalkeith Railway,..... 21
Self-acting Break for Railway Carriages, Stephenson's..... 50
Self-acting Safety Winding Cateh for Mine Shafts, 58
Sewer Diaphragm, Double,..... 255
Sewers, Flap-Valve for,..... 230
Shears, Silent,..... 210
Ships' Spars, Proportions of,..... 66
Shipwreck, on Rendering Ship Furniture available in,..... 170
Signalling, Employment of Bells for Railway,..... 212
Silver, Production of, in Spain,..... 105
Simpson, the Mathematician,..... 28
Sliding Parallel Ruler,..... 20
Slotting and Shaping Machine, Shanks,..... 73
Smoke, Prevention of,..... 167
Smoke Protector, Scotland's,..... 199
Society of Arts—(See "Proceedings of Scientific Societies.")
Society, Royal Scottish—(See ditto.)
Sound, Effect of the Rapid Motion of the Observer on,..... 142
Sound, Speed of,..... 223
South Australian Copper Mines, Account of the, 8
Specimens, Late, of Glyphography,..... 32
Spheroidal Condition of Water,..... 200
Spiral Springs, Elasticity and Strength of,..... 243
Steele, Thomas, Biography of,..... 260
Stephenson, Death of George,..... 135
Stephenson, Life and Character of George,..... 205
Stars, Hand-Book for the, Jeans,..... 183
Stop-Cock for Corrosive Fluids,..... 129
Stuffing-Boxes, Hunt's Metallic Packing for,..... 176
Steam Boilers, Alarm Whistle and Pressure Gnage, ... 20
Steam Boiler, and Condenser for,..... 117
" Boilers, Corrosion of Stone Floats in,..... 136
" Boiler Explosions, Prevention of,..... 136
" Boiler Explosions,..... 140
" Boiler Explosion at Dudley,..... 117
" Boiler Explosions, Injection of Cold Feed Water,..... 184
" Boiler Safety-Valve, Walmsley's,..... 181
" Boiler Water Guage,..... 43
" Boiler Water Guage, and Feeder for,..... 65
" Carriage for Common Roads,..... 119
" Chemical Character of,..... 163
" Engine, Beauregard's Patent,..... 200
" Engine Boiler, M'Naught's, Plates 18, 19,.. 177
" Engine, Craddock's Improvements in,..... 112
" Engine, Cambrian,..... 236
" Engines, Causes of Explosions in,.....105, 111
" Engine, Chemistry of,..... 43, 67
" Engine, Gilbert's Double Cylinder,..... 239
" Engine, High-Pressure, Alban,..... 86, 109
" Engine, Joyce's Double Cylinder Pendulous,..... 9, 33
" Engine Management—Boiler Explosions,. 145
" Engine, M'Naught's Double Cylinder, 35, 152
" Engines, M'Naught's Improvements in,... 69

PAGE

Steam Engines, on the Effect of Atmospheric Pressure on,..... 214, 234
" Engines, Prevention of Explosions in,..... 234
" Engine, Rotatory,..... 138
" Engine, Rudimentary Treatise on, by Lardner,..... 231
" Engine, Slide-Valve for,..... 44
" Engine, Tredgold on the,..... 159, 232
" Expansion of,..... 232
" Frigate "Vladimir,"..... 178
" Hammer, Self-acting Apparatus for,..... 77
" Link Motion for,..... 160
" Navigation, Improvements in, ... 165
" Phenomenon attending on the Discharge of High-pressure,..... 214, 235
" Physical Properties of, Curr,..... 281
" Preparation of Wood,..... 106
" Propeller for Fan-Blower,..... 154
" Oscillating Marine,..... 58, 80
" Saw for Cutting Railway Bars,..... 173
" Tug "Wizard,"..... 107
" Vessel "Cricket,"..... 23
" Vessel "Foyle,"..... 66
Sugar Moulds, Apparatus for Casting, Campbell and Macnah,..... 280
Sulphur,..... 34
Sun, the,..... 172
Swage-Block and Tap-Guide,..... 223

T

Table-knife with Immoveable Blade,..... 220
Teeth of Wheels,..... 71
Telescope, Invention of,..... 36
Thames Steamers,..... 217
Theatres and Porticoes of Ancient Rome,... 100, 132
Thermanterion Warming Apparatns, Spiller and Taylor's,..... 243
Thermometer, Self-registering,..... 161
Thermometric Observations,..... 183, 212, 258, 283
Tile Machine, Stop-cutting Apparatus for,..... 280
Time, Notation of,..... 191
"Times" Printing Machine,..... 248
Trades, Rapid Extension of certain,..... 22
Trawl-Fishing Apparatns, Mr. Dempster's, 219, 239
Triforium of Ancient Churches,..... 118
Trigonometry, Plane and Spherical,..... 18

U—V

Uritype,..... 222
Velocentimeter,..... 164
Velocity and Height of Waves,..... 186
Ventilator, New Mine,..... 164
Viaduct across the Dee,..... 167
Vulcanized India-rubber for Pipe Joints,..... 236

W

Waggons, Improved Covering for, Hill's,..... 226
Warming Apparatus, Spiller and Taylor's,..... 243
Warps, Cochran's Improvements in Printing,..... 41
Water Cements of England,..... 62
Water, Guage-pipe for Measuring the Flow of,... 130
Water, Steam, and Air, Relative Density of,..... 233
Water, Surplus Supply of Manchester,..... 110, 158
Water Supply of Plymouth, Beardmore,..... 280
Water-wheels, Fairbairn's Improved Form of,.... 259
Well Digging, Boring, and Pump-work, Swindell, 256
Wheel Tyre Bending Machine,..... 58
Wheel Tyres, Evan's Improvements in,..... 57
Wheels, Teeth of, ... 71
Wheels, Railway, Comparative Account of,..... 112
Whistle and Pressure-Gnage for Boilers,..... 20
Winding Catch for Mine Shafts, Simpson's,..... 58
Wood, Payne's Patent for Preserving,..... 166
Wood, Steam Preparation of,..... 106
Workshop Economics:—
Constructive Machinery—Shanks' Slotting and Shaping Machine,..... 73
Crank Cutting Machine,..... 104
Nasmyth's Tap-Guide and Swage-Block,..... 223
Wornell's "Stricken Deer,"..... 262

SMITHSONIAN INSTITUTION LIBRARIES

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01549 2259